

# **MAG REGIONAL FREEWAY BOTTLENECK STUDY**

## **PRELIMINARY DRAFT WORKING PAPER FOR:**

**TASK 6 - BOTTLENECK ANALYSIS WORKING PAPER**

**TASK 7 - BOTTLENECK IMPROVEMENT SOLUTIONS**

**TASK 8 - BOTTLENECK IMPROVEMENTS BENEFITS**

Part 2

**Draft Date:  
October 10, 2002**

***Submitted to:*  
THE MARICOPA ASSOCIATION OF GOVERNMENTS**

***Prepared by:***



**OLSSON ASSOCIATES**

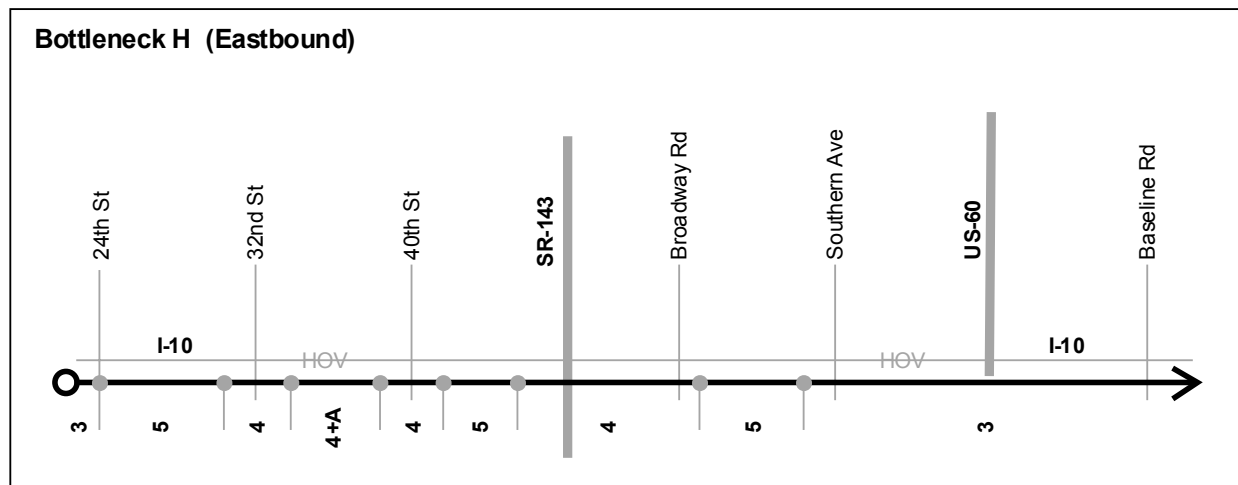
**Draft**

# **SEGMENT H** **I -10 EASTBOUND: 24TH STREET TO BASELINE ROAD** **EVENING PEAK PERIOD**

## **EXISTING CONDITIONS**

### *Geometrics:*

The following schematic illustrates the lane configuration along the H bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



### *Daily Traffic Volume, Both Directions:*

Daily traffic volume along the H bottleneck segment reaches a maximum of 240,000 vehicles (vpd) at the intersection of I-10 and Broadway Rd (the “Broadway Curve”). The volume at this location during the PM peak hour is 20,700, which represents 8.6 percent of the total daily volume.

### *Eastbound Traffic Volumes:*

The volumes shown in the table below represent eastbound counts along the H bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

## **TRAFFIC VOLUMES**

Location	PM Peak Hour Total Volume	PM Peak Hour GP Volume	PM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
I-10 / 32 <sup>nd</sup> St	8,700	8,100	600	8.1%	1.3%
I-17 / Broadway Rd	10,800	-----	-----	9.2%	-----

## CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

### CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	325	1.36	203	61	50	11
1999	315	1.30	173	62	64	16
2000	286	1.16	174	47	47	18
Total	926	1.28	550	170	161	45

### CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	325	247	78	0	28
1999	315	243	72	0	27
2000	286	202	84	0	28
Total	926	692	234	0	83

## SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

**Observations:** During the peak period, eastbound congestion was found on I-10 between I-17 and Southern Avenue; average estimated speeds typically ranged from 30 to 50 mph. Contributing factors to the congestion were 1) the lane drop (5 lanes to 4) at University Drive, and 2) vehicles merging into the two right lanes to exit at US-60.

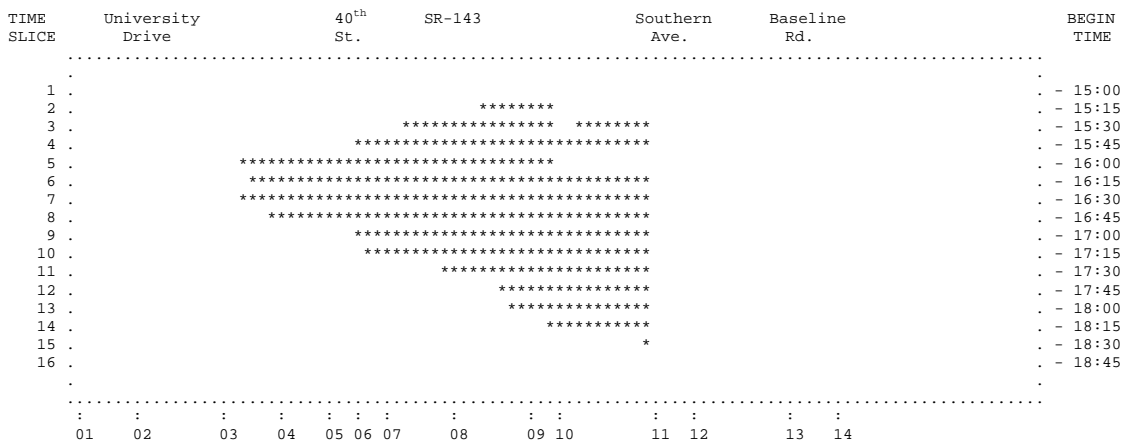
**Density Data:** (no data collected after 6:00 pm): Level of Service F (density greater than 45 vehicles per lane-mile) between University Drive and 40<sup>th</sup> Street between 4:00 and 6:00 pm and between 40<sup>th</sup> Street and the US-60 exit-ramp between 5:00 and 6:00 pm.

## FREQ ANALYSIS

**Segment H:** I-10 EB; 24th Street to Baseline Road; 3:00 to 7:00 pm

**Existing Conditions:** Existing bottlenecks occur at Broadway Road and the I-10/US-60 interchange. The congestion extends from US-60 to University Drive. The bottleneck at I-10/US-60 is caused by merging traffic from the upstream SR-143 on-ramp and merging/weaving at the US-60 off-ramp. The recent construction of the HOV flyover ramp, connecting I-10 with US-60 has eliminated some of the merging problem.

### Queue Diagram of Existing Conditions for Segment H:



#### Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

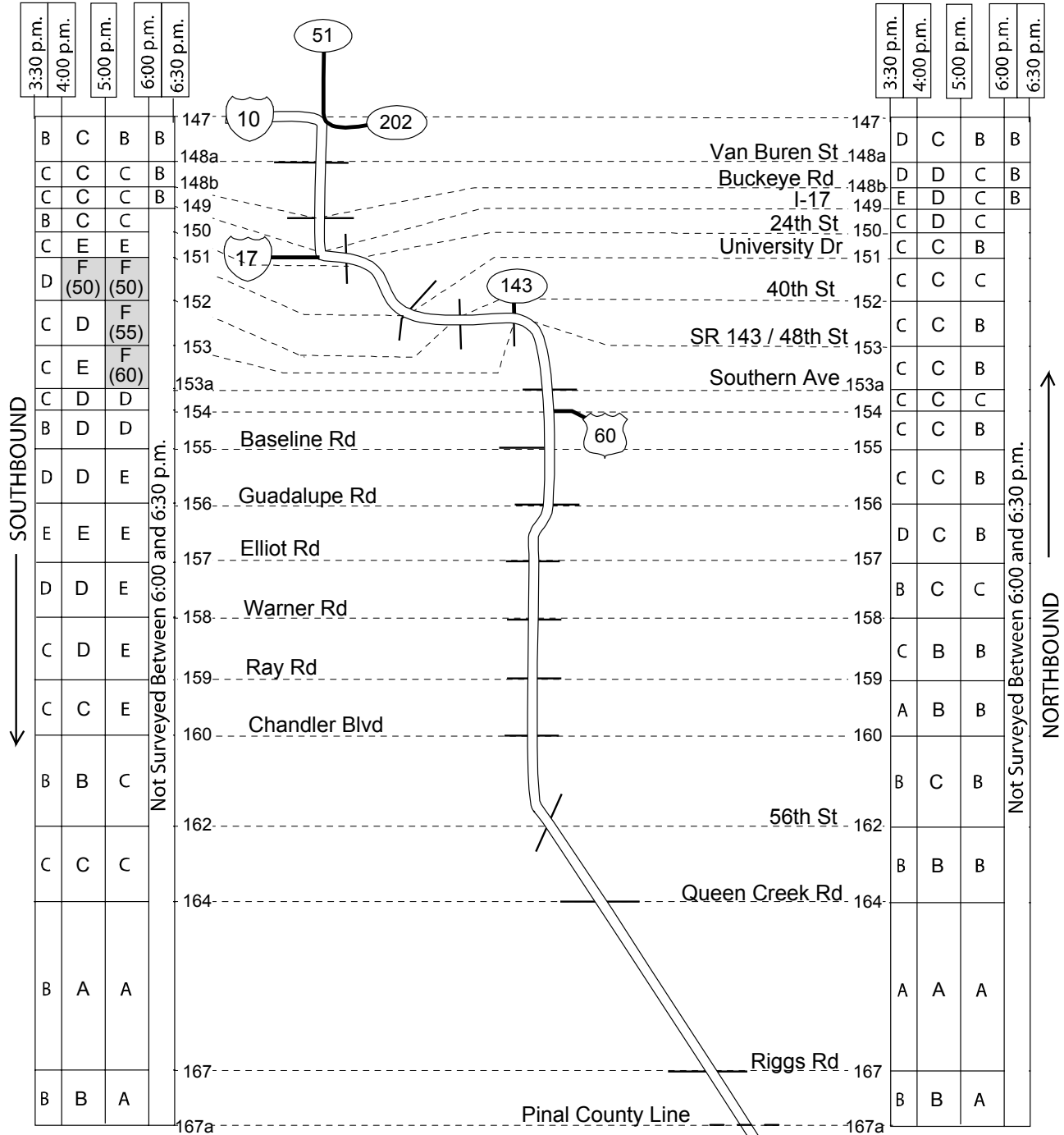
ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

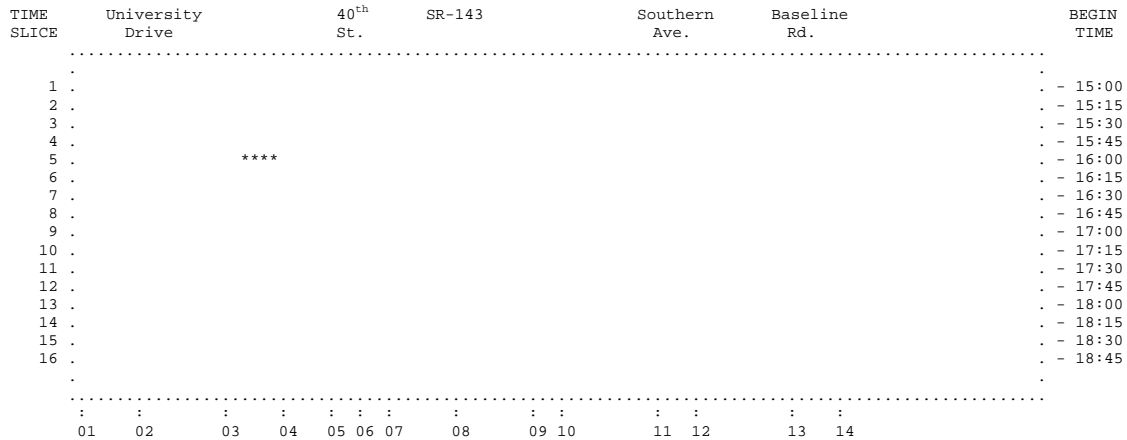
**I-10**  
**(Between SR 202 / SR 51 & Chandler Blvd)**  
**Evening - Fall 2001**



**Alternative 1:** Add a collector-distributor road from SR-143 to Baseline Road.

**Result:** Removing the merging/weaving problem created by the traffic entering at the SR-143 on-ramp eliminates the bottleneck at the I-10/US-60 interchange. Overall mainline travel time decreases 38%. A detailed analysis of collector-distributor road operation is needed to determine overall freeway impacts.

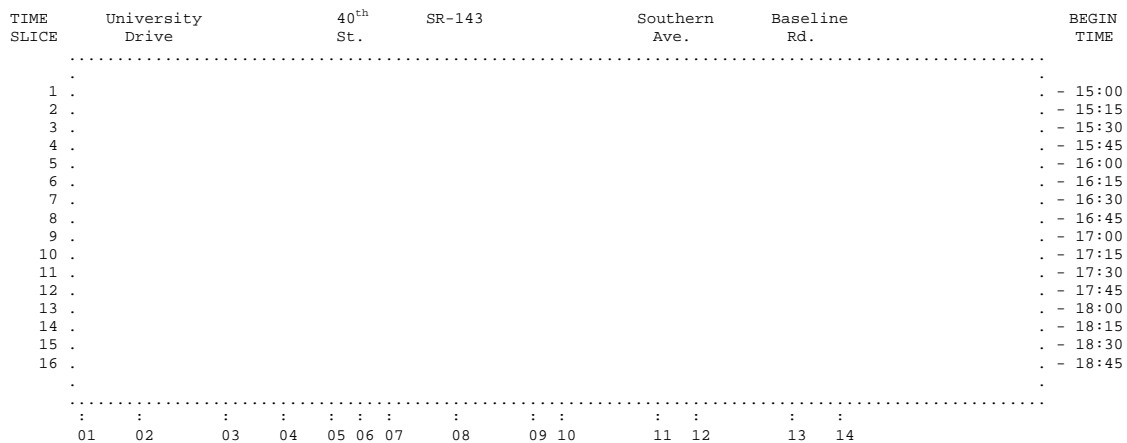
**Queue Diagram of Alternative 1 for Segment H:**



**Alternative 2:** Add a collector-distributor road from 24<sup>th</sup> Street to Baseline Road.

**Result:** Similar results as Alternative 1. Overall mainline travel time decreases 43%. A detailed analysis of collector-distributor road operation is needed to determine overall freeway impacts.

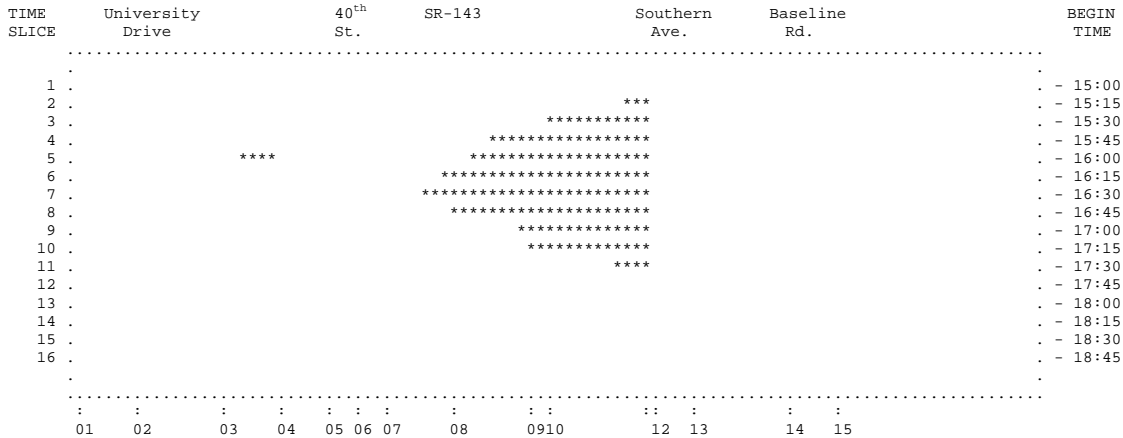
**Queue Diagram of Alternative 2 for segment H:**



**Alternative 3:** Include the left side HOV ramp connecting the southbound I-10 to eastbound US-60 HOV lanes. This ramp has been completed and is currently in operation.

**Result:** This alternative reduces the congestion created by the merging/weaving. Overall freeway travel time decreases 8%.

### Queue Diagram of Alternative 3 for Segment H:



### ANALYSIS SUMMARY – SEGMENT H

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	5987	6528	12515	42.7
Alternative 1	3642	4201	7844	66.2
Alternative 2	3352	3865	7217	69.8
Alternative 3	5015	6529	11544	50.8

### Conclusions/Recommendations:

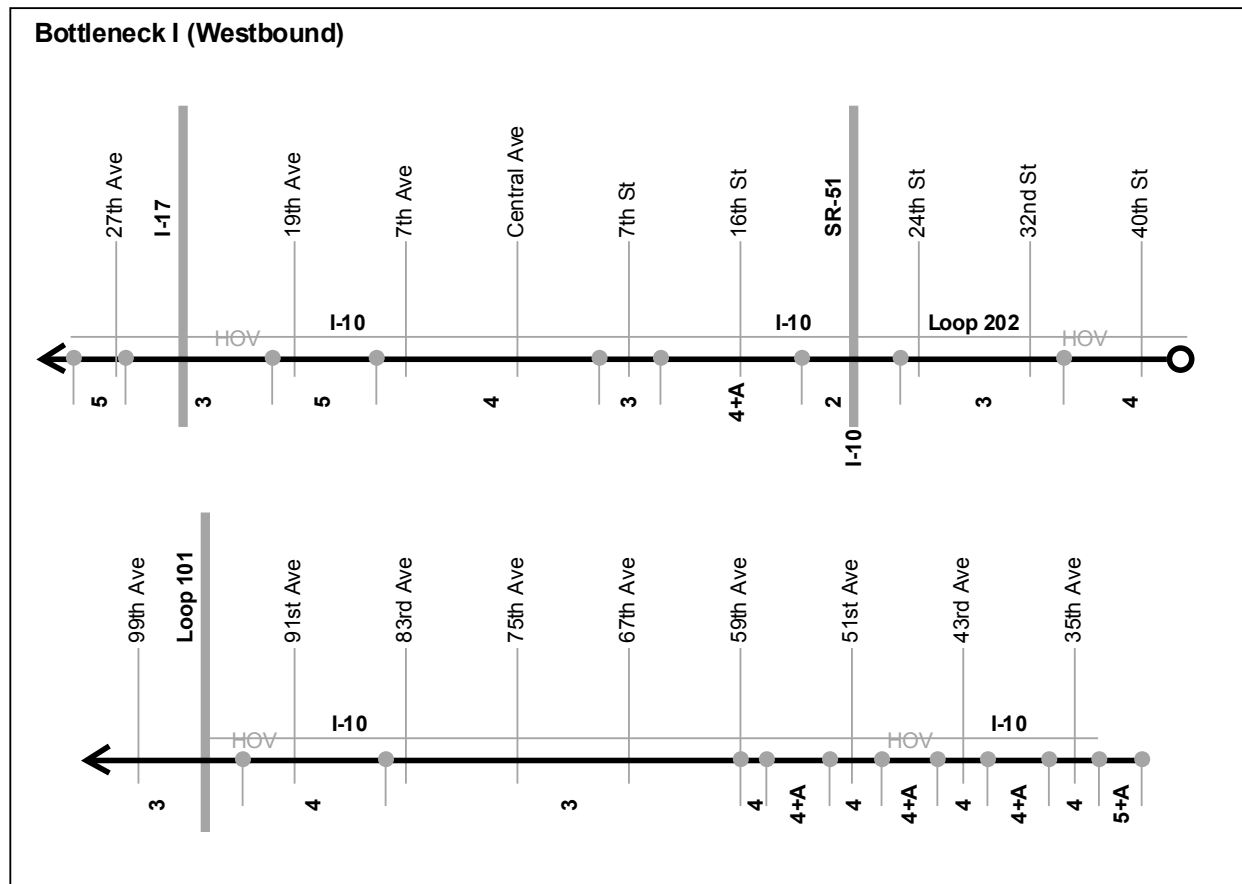
1. The addition of a collector-distributor road from SR-143 to Baseline Road will significantly reduce the congestion created by merging/weaving between SR-143 and US-60. The on-going collector-distributor road study will provide a detailed assessment of the impacts on mainline traffic flow, collector-distributor road operations, and access.

**SEGMENT I**  
**I-10 WESTBOUND: 40<sup>TH</sup> STREET (ON LOOP 202) TO 99<sup>TH</sup> AVENUE**  
**EVENING PEAK PERIOD**

**EXISTING CONDITIONS**

*Geometrics:*

The following schematic illustrates the lane configuration along the I bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



*Daily Traffic Volume, Both Directions:*

Daily traffic volume along this bottleneck segment reaches a maximum of 259,000 vehicles (vpd) at the intersection of I-10 and 7<sup>th</sup> Street. The volume at this location during the PM peak hour is 16,200 for General Purpose lanes and 3,000 for HOV lanes. These combined peak hour volumes represent 7.4% of the total daily volume.



*Westbound Traffic Volumes:*

The volumes shown in the table below represent westbound counts along the I bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

**TRAFFIC VOLUMES**

<b>Location</b>	<b>PM Peak Hour Total Volume</b>	<b>PM Peak Hour GP Volume</b>	<b>PM Peak Hour HOV Volume</b>	<b>Percent Peak Hour</b>	<b>Percent Peak Hour Trucks</b>
Loop 202 / 32 <sup>nd</sup> St	7,200	7,100	100	7.4%	0.4%
I-10 / 16 <sup>th</sup> St	9,700	8,100	1,600	7.1%	2.1%
I-10 / 7 <sup>th</sup> Av	7,400	5,800	1,600	6.6%	-----
I-10 / 31 <sup>st</sup> Av	10,100	8,800	1,300	9.0%	3.6%
I-10 / 51 <sup>st</sup> Av	5,000	4,500	500	6.1%	-----
I-10 / 75 <sup>th</sup> Av	7,400	6,500	900	9.5%	3.0%

**CRASH DATA**

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

**CRASH DATA – COLLISION TYPE**

<b>Year</b>	<b>Total Crashes</b>	<b>Crash Rate</b>	<b>Rear End</b>	<b>Sideswipe</b>	<b>Single Vehicle</b>	<b>Other</b>
<b>1998</b>	1177	2.16	896	131	119	31
<b>1999</b>	1050	1.84	801	122	94	33
<b>2000</b>	1239	2.07	914	175	122	28
<b>Total</b>	3466	2.02	2611	428	335	92

**CRASH DATA – SEVERITY**

<b>Year</b>	<b>Total Crashes</b>	<b>PDO</b>	<b>Injury</b>	<b>Fatal</b>	<b>Truck Involved</b>
<b>1998</b>	1177	885	289	3	46
<b>1999</b>	1050	773	274	3	49
<b>2000</b>	1239	867	368	4	73
<b>Total</b>	3466	2525	931	10	168

## SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on pages I-5 and I-6.

*Observations:* During most observations, westbound congestion was typically found in Loop 202 between 32<sup>nd</sup> Street and I-10/SR-51; average estimated speeds typically ranged from approximately 25 to 50 mph. This congestion appeared to be caused or exacerbated by the lane drop [3 lanes to 2] at I-10 / SR-51.

Before 4:30 pm, a short zone of westbound congestion was found in I-10 between SR-51/Loop 202 and 7<sup>th</sup> Street; average estimated speeds along this segment typically ranged from 30 to 50 mph. This congestion appeared to be caused or exacerbated by the lane drops [5 lanes to 4 and 4 lanes to 3] in the vicinity of 7<sup>th</sup> Street.

During the peak period, westbound congestion was found in I-10 between the vicinity of I-17 and 67<sup>th</sup> Avenue. Contributing factor to the congestion were 1) the lane drop [5 lanes to 4] at 35<sup>th</sup> Avenue and 2) the lane drop [4 lanes to 3] at 59<sup>th</sup> Avenue. Average speeds along this segment typically ranged from approximately 20 to 40 mph.

*Density Data:* Level of Service F (density greater than 45 vehicles per lane-mile) between 24<sup>th</sup> Street and 32<sup>nd</sup> Street between 3:30 and 4:00 pm, and again between 5:00 and 6:00 pm; between Van Buren Street and 56<sup>th</sup> Street between 5:00 and 6:30 pm; between 56<sup>th</sup> Street and McClintock Drive between 3:30 and 6:30 pm; between 67<sup>th</sup> Avenue and 59<sup>th</sup> Avenue between 3:30 and 4:00 pm and again between 5:00 and 6:00 pm; between 59<sup>th</sup> Avenue and 51<sup>st</sup> Avenue between 3:30 and 6:30 pm; between 51<sup>st</sup> Avenue and 19<sup>th</sup> Avenue between 5:00 and 6:00 pm; and between 7<sup>th</sup> Street and 16<sup>th</sup> Street between 3:30 and 4:00 pm.

## FREQ ANALYSIS

**Segment I:** I-10 WB; 40<sup>th</sup> Street to 99<sup>th</sup> Avenue; 3:00 to 7:00 pm

**Existing Conditions:** Bottlenecks currently exist at the Loop 202/SR-51/I-10 interchange, 7<sup>th</sup> Street, 35<sup>th</sup> Avenue, 59<sup>th</sup> Avenue and 67<sup>th</sup> Avenue. Merging and weaving of traffic between the westbound Loop 202/SR-51 traffic and I-10 traffic are major contributors to congestion.

### Queue Diagram of Existing Conditions for Segment I:

TIME SLICE	40 <sup>th</sup> St.	24 <sup>th</sup> St.	7 <sup>th</sup> St.	7 <sup>th</sup> Ave.	27 <sup>th</sup> Ave.	35 <sup>th</sup> Ave.	BEGIN TIME														
1	*****BBBBB*****						- 15:00														
2	*****BBBBBBBBBBBB*****						- 15:15														
3	*****BBBBBBBBBBBBBBBB*****						- 15:30														
4	*****BBBBBBBBBBBBBBBB*****						- 15:45														
5	*****BBBBBBBBBBBBBBBB*****						- 16:00														
6	*****BBBBBBBBBBBBBBBB*****						- 16:15														
7	*****BBBBBBBBBBBBBBBB*****						- 16:30														
8	*****BBBBBBBBBBBBBBBB*****					*	- 16:45														
9	*****BBBBBBBBBBBBBBBB*****					***	- 17:00														
10	*****BBBBBBBBBBBBBBBB*****				*	*****	- 17:15														
11	*****BBBBBBBBBBBBBBBB*****				*	*****	- 17:30														
12	*****BBBBBBBBBBBBBBBB*****					**	- 17:45														
13	*****BBBBBBBBBBBBBBBB*****						- 18:00														
14	*****BBBBBBBBBBBBBBBB*****						- 18:15														
15	*****BBBBBBBBBBBBBBBB*****						- 18:30														
16	*****BBBBBBBBBBBBBBBB*****						- 18:45														
	01	02	03	04	05	06	08	10	11	12	14	15	16	17	18	19	20	21	22		
CONT From ABOVE	TIME SLICE	43 <sup>rd</sup> Ave.	59 <sup>th</sup> Ave.	67 <sup>th</sup> Ave.	SR-101					BEGIN TIME											
1																				- 15:00	
2																				- 15:15	
3				***			**													- 15:30	
4				***																- 15:45	
5	***	*****		***																- 16:00	
6				***																- 16:15	
7	****	*****		****																- 16:30	
8	*****	*****		*****																- 16:45	
9	*****	*****		*****																- 17:00	
10	*****	*****		*****			****													- 17:15	
11	*****	*****		*****			***													- 17:30	
12	*****	*****		*****																- 17:45	
13	****	*****		****																- 18:00	
14																				- 18:15	
15																				- 18:30	
16																				- 18:45	
		24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43

### Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

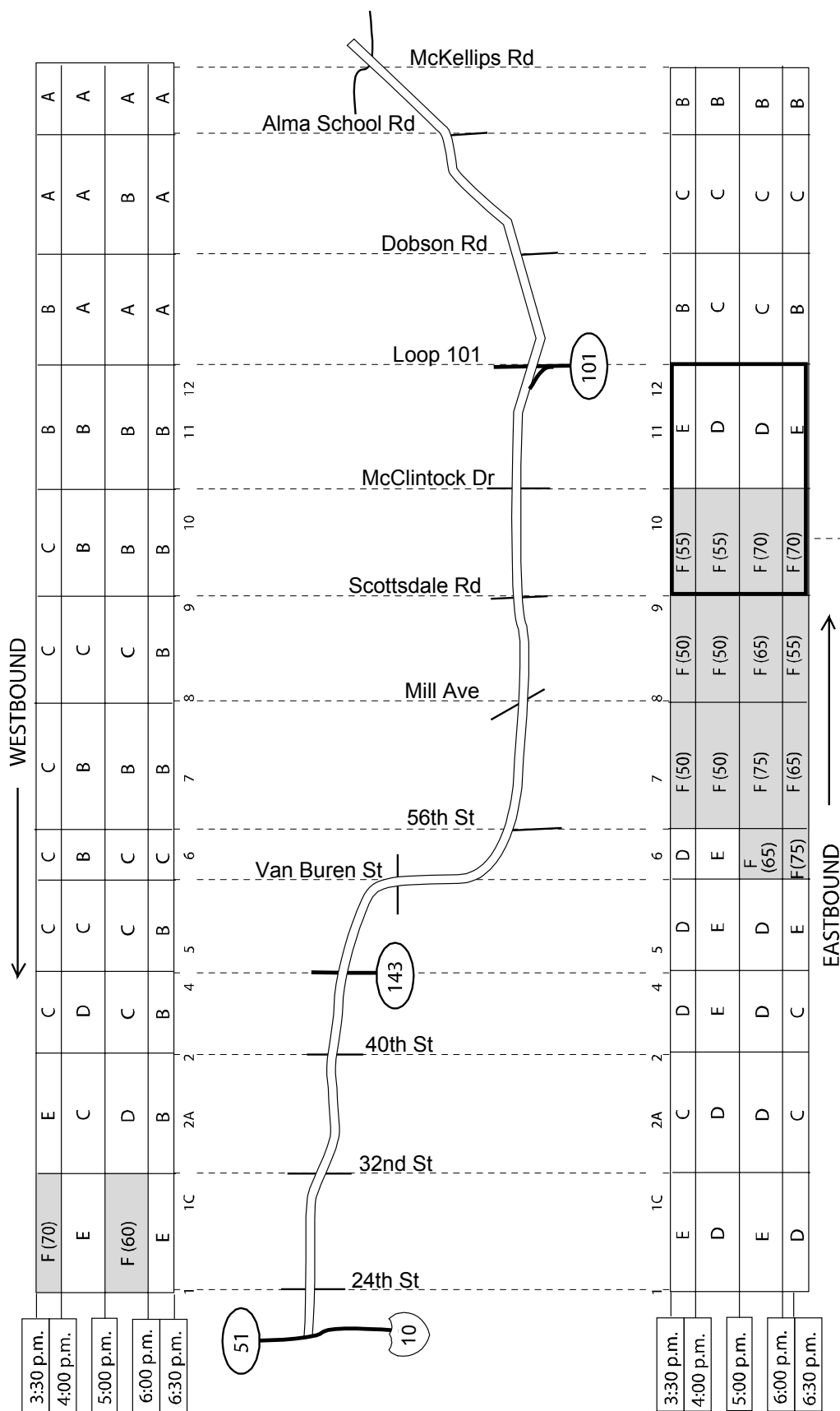
ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

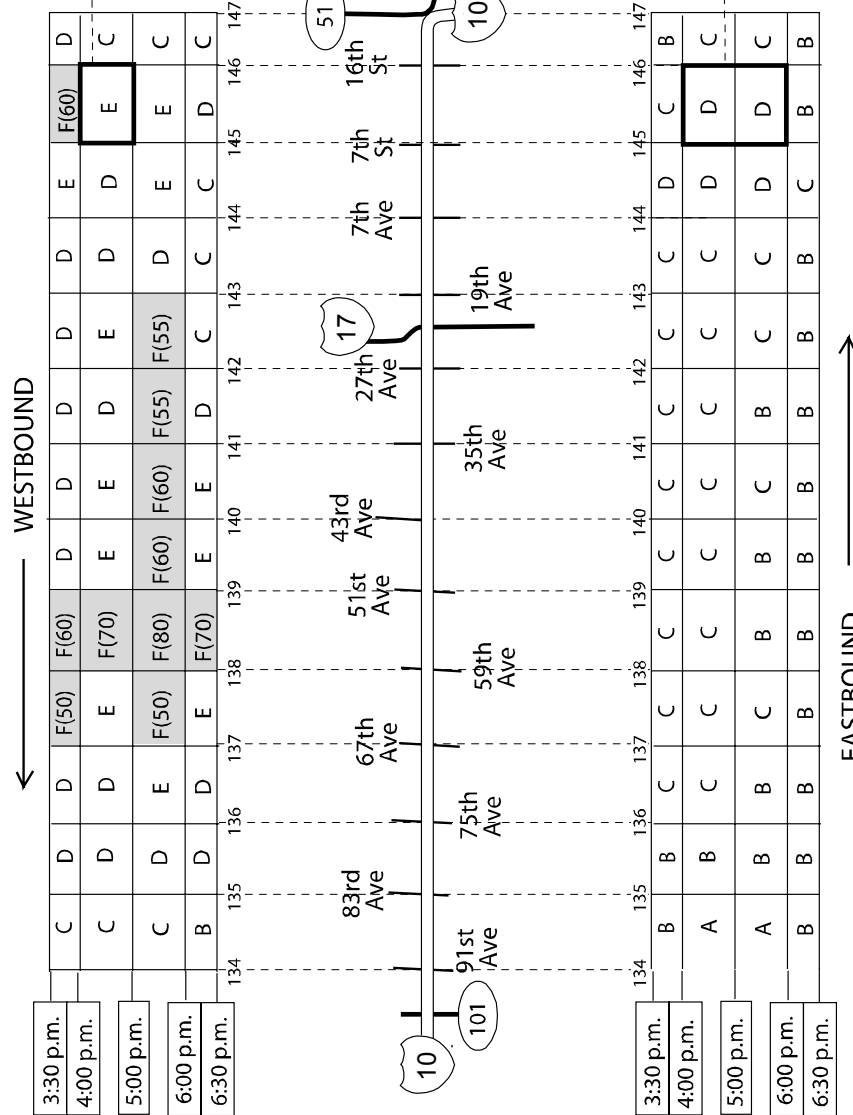
## Loop 202 Evening - Fall 2001



**I-10 □  
(Between 91st Ave & Loop 202 / SR 51)  
Evening - Fall 2001**

These level-of-service ratings represent the mathematical average of densities, which varied from day-to-day (congested/not congested); when congested, densities typically ranged between 55 and 45 pcplpm with corresponding speed estimates of 40 to 50 mph.

These level-of-service ratings represent the mathematical average of densities, which varied widely between right- and left-hand lanes. When congested densities in the right lane approaching the SR 51/Loop 202/I-10 Interchange ranged between 55 and 45 pcplpm with corresponding speed estimates of 40 to 50 mph.



LEVEL-OF-SERVICE LEGEND:

LIGHT	MODERATE	HEAVY	CONGESTED	SEVERE
A	B	C	D	E
0	10	20	30	45
				65

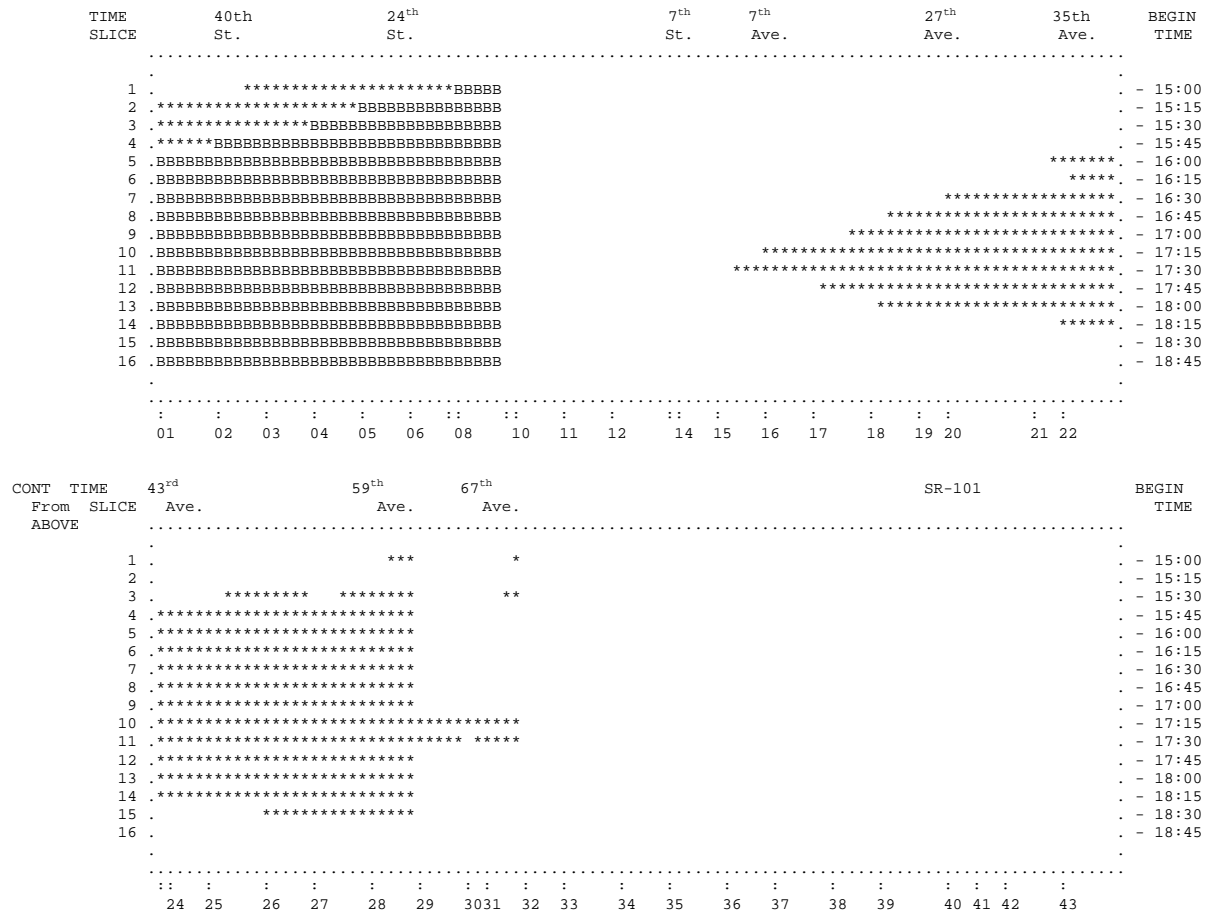
Density scale (cars per lane-mile)

Note: F (60) in the tables means level-of-service "F", with density = 60

**Alternative 1:** Change the I-10 HOV lane from the Loop 202 interchange to the I-17 interchange into a general purpose lane and allow all traffic to exit at the 3<sup>rd</sup> Street left exit-ramp.

**Result:** This alternative eliminated congestion caused by the 7<sup>th</sup> Street bottleneck, however, the resulting increase in demand downstream creates worse congestion at the 59<sup>th</sup> Avenue and 35<sup>th</sup> Avenue bottlenecks. Overall, freeway travel time increases slightly.

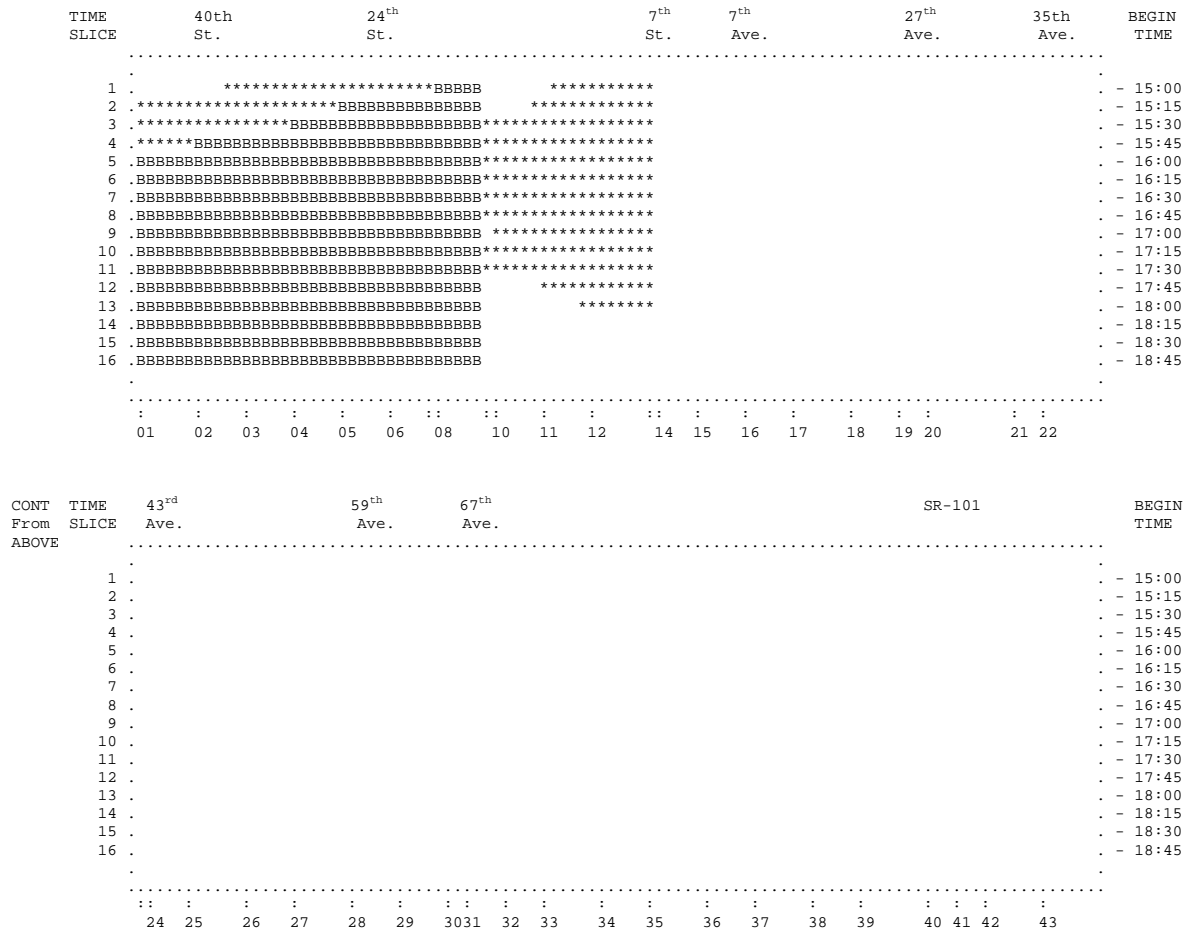
### Queue Diagram of Alternative 1 for Segment I:



**Alternative 2:** Add an additional general purpose lane and auxiliary lanes between 35<sup>th</sup> Avenue and 67<sup>th</sup> Avenue.

**Result:** This alternative eliminates congestion at these two bottlenecks. Overall, freeway travel time decreases 4%.

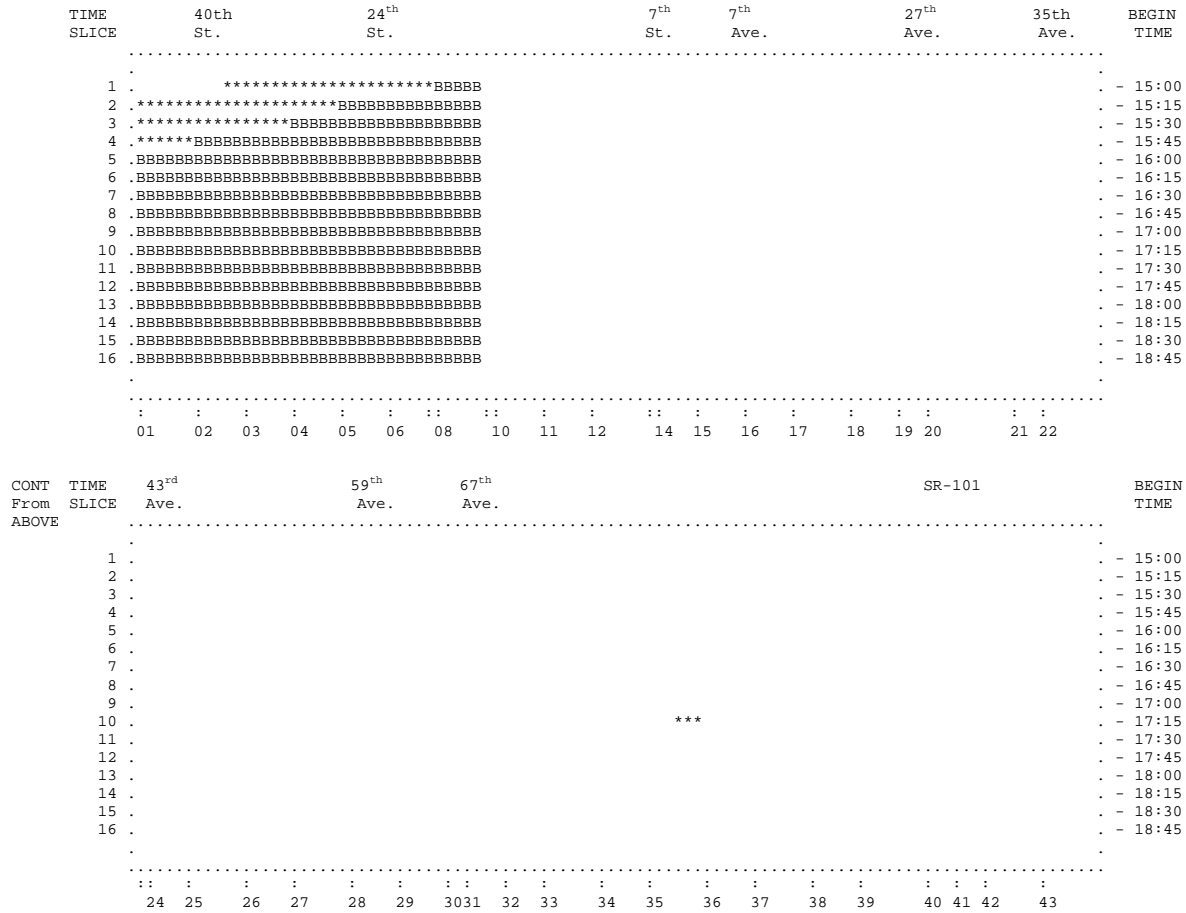
### Queue Diagram of Alternative 2 for Segment I:



**Alternative 3:** Combine Alternative 1 and Alternative 2: convert the downtown HOV lane to a general purpose lane with access to the 3<sup>rd</sup> Street off-ramp and add a general purpose lane and auxiliary lanes between 35<sup>th</sup> Avenue and 67<sup>th</sup> Avenue

**Result:** Congestion caused by bottlenecks at 7<sup>th</sup> Street, 35<sup>th</sup> Avenue and 67<sup>th</sup> Avenue is eliminated. Congestion associated with the Loop 202/SR-51/I-10 remains. Overall, freeway travel times decrease 9%.

### Queue Diagram of Alternative 3 for Segment I:

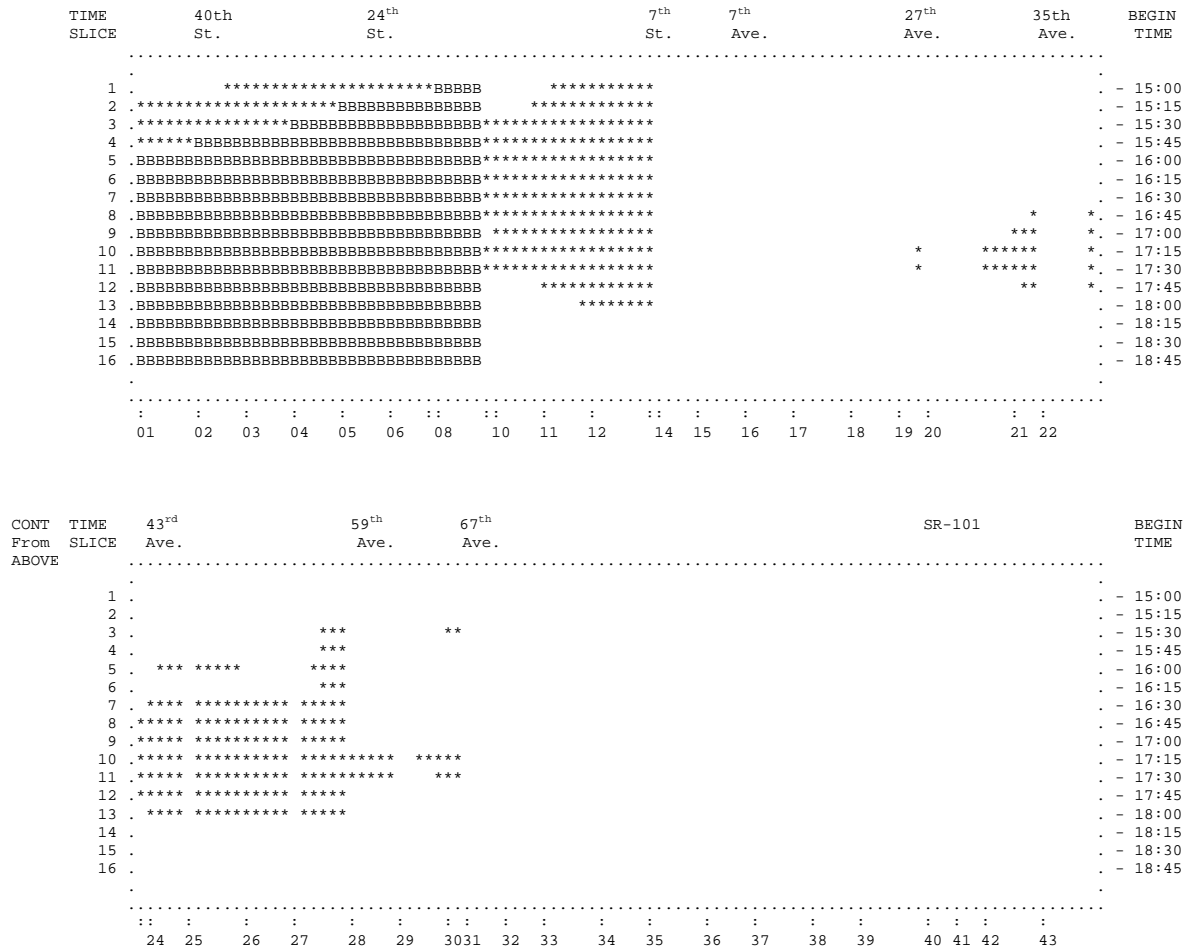




**Alternative 4:** Add an additional general purpose lane and auxiliary lanes between 59<sup>th</sup> Avenue and 91<sup>st</sup> Avenue, as well as an additional through lane between 7<sup>th</sup> Street and 7<sup>th</sup> Avenue.

**Result:** This alternative improved traffic flow at the 59<sup>th</sup> Avenue bottleneck somewhat. Overall, freeway travel time remains essentially unchanged.

### Queue Diagram of Alternative 4 for Segment I:



**Alternative 5:** Add an additional general purpose lane between 7<sup>th</sup> Street and 7<sup>th</sup> Avenue and construct a 4+1+A cross section from 59<sup>th</sup> Avenue to 83<sup>rd</sup> Avenue.

**Result:** This alternative cleared up the 7<sup>th</sup> Street bottleneck moving traffic downstream, thus increasing the delays at the 59<sup>th</sup> Avenue bottleneck.

### Queue Diagram of Alternative 5 for Segment I:

TIME SLICE	40th St.	24 <sup>th</sup> St.	7 <sup>th</sup> St.	7 <sup>th</sup> Ave.	27 <sup>th</sup> Ave.	35th Ave.	BEGIN TIME
1	*****	*****					- 15:00
2	*****	*****					- 15:15
3	*****	*****					- 15:30
4	*****	*****					- 15:45
5	*****	*****					- 16:00
6	*****	*****					- 16:15
7	*****	*****					- 16:30
8	*****	*****					- 16:45
9	*****	*****					- 17:00
10	*****	*****					- 17:15
11	*****	*****					- 17:30
12	*****	*****					- 17:45
13	*****	*****					- 18:00
14	*****	*****					- 18:15
15	*****	*****					- 18:30
16	*****	*****					- 18:45
:	:	:	:	:	:	:	:
01	02	03	04	05	06	07	08
10	11	12	14	15	16	17	18
19	20	21	2				

CONT From ABOVE	TIME SLICE	43 <sup>rd</sup> Ave.	59 <sup>th</sup> Ave.	67 <sup>th</sup> Ave.	SR-101	BEGIN TIME
1	.	***				- 15:00
2	.					- 15:15
3	.	*****	*****			- 15:30
4	.	*****	*****			- 15:45
5	.	*****	*****			- 16:00
6	.	*****	*****			- 16:15
7	.	*****	*****			- 16:30
8	.	*****	*****			- 16:45
9	.	*****	*****			- 17:00
10	.	*****	*****			- 17:15
11	.	*****	*****			- 17:30
12	.	*****	*****			- 17:45
13	.	*****	*****			- 18:00
14	.	*****	*****			- 18:15
15	.	*****	*****			- 18:30
16	.					- 18:45
:	:	:	:	:	:	:
3	24	25	26	27	28	29
30	31	32	33	34	35	36
37	38	39	40	41	42	

## ANALYSIS SUMMARY – SEGMENT I

	<b>Mainline Travel Time (pass-hr)</b>	<b>Ramp Delay (pass-hr)</b>	<b>Total Freeway Travel Time (pass-hr)</b>	<b>Average Speed (mph)</b>
Existing Conditions	14344	19345	33689	34.1
Alternative 1	15105	19077	34182	35.1
Alternative 2	13142	19345	32486	37.3
Alternative 3	11827	19079	30906	44.7
Alternative 4	14177	19345	33522	34.6
Alternative 5	14812	19087	33899	34.3

### Conclusions/Recommendations:

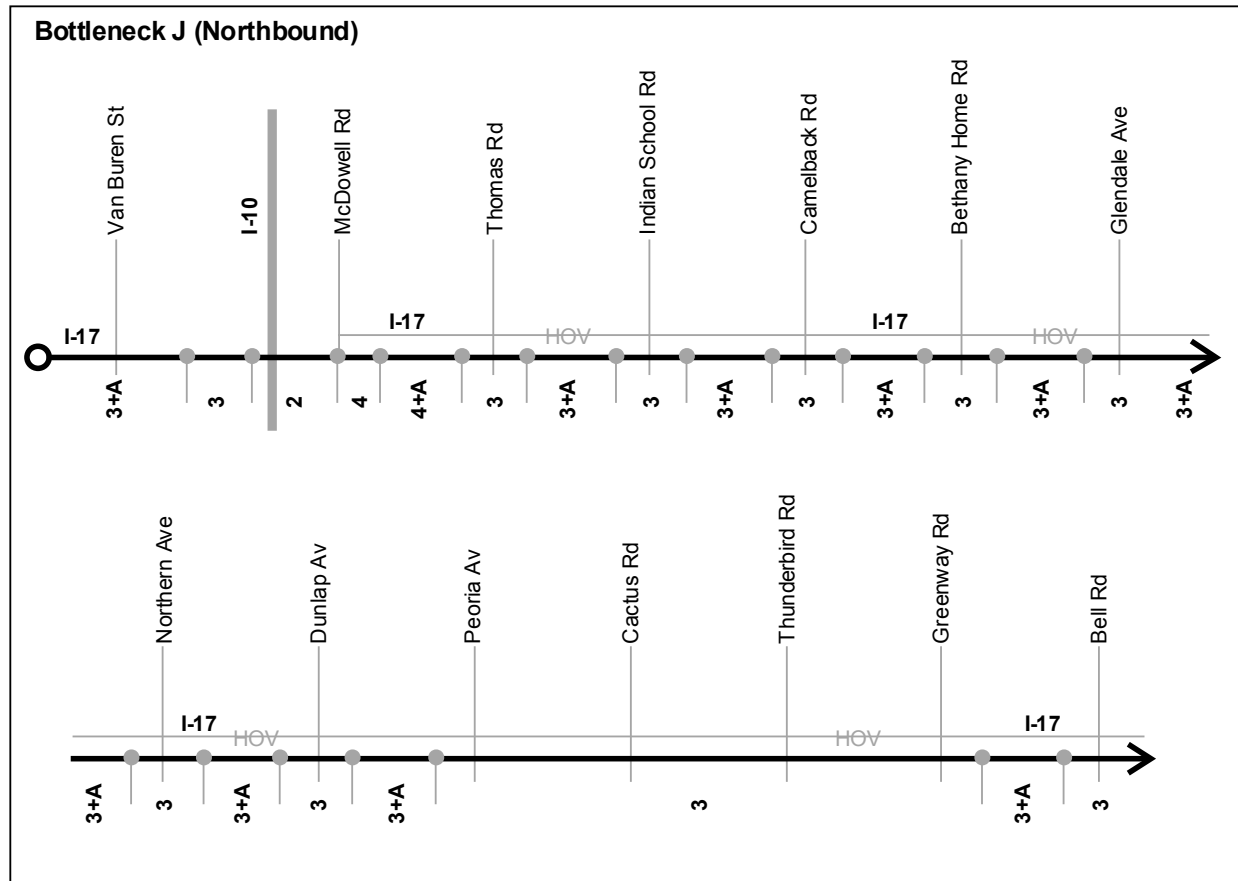
1. Analysis of various alternatives indicates that significant improvements are needed to produce an appreciable reduction in congestion. These improvements include adding additional general purpose capacity in the tunnel segment (7<sup>th</sup> Street to 7<sup>th</sup> Avenue) and widening the freeway section from 35<sup>th</sup> Avenue to 67<sup>th</sup> Avenue to a 5+1+A cross section.
2. Improvements to increase the capacity at the Loop 202/SR-51/I-10 interchange will increase downstream demand and should not be considered without implementing the capacity enhancements at the 7<sup>th</sup> Street and 67<sup>th</sup> Avenue bottlenecks.

**SEGMENT J**  
**I-17 NORTHBOUND: VAN BUREN STREET TO BELL ROAD**  
**EVENING PEAK PERIOD**

**EXISTING CONDITIONS**

*Geometrics:*

The following schematic illustrates the lane configuration along the J bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



*Daily Traffic Volume, Both Directions:*

Daily traffic volume along the J bottleneck segment reaches a maximum of 208,000 vehicles (vpd) along I-17 at Campbell Rd. The volume at this location during the PM peak hour is 13,900, which represents 6.7% of the total daily volume.

*Northbound Traffic Volumes:*

The volumes shown in the table below represent northbound counts along the J bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

**TRAFFIC VOLUMES**

<b>Location</b>	<b>PM Peak Hour Total Volume</b>	<b>PM Peak Hour GP Volume</b>	<b>PM Peak Hour HOV Volume</b>	<b>Percent Peak Hour</b>	<b>Percent Peak Hour Trucks</b>
I-17 / Van Buren St	6,600	-----	-----	10%	-----
I-17 / Campbell Rd	7,300	5,900	1,400	7.3%	0.9%
I-17 / Glendale Av	7,700	6,500	1,200	7.8%	1.7%
I-17 / Peoria Av	7,100	-----	-----	7.3%	-----
I-17 / Thunderbird Rd	6,700	5,400	1,300	8.3%	1.0%

**CRASH DATA**

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

**CRASH DATA – COLLISION TYPE**

<b>Year</b>	<b>Total Crashes</b>	<b>Crash Rate</b>	<b>Rear End</b>	<b>Sideswipe</b>	<b>Single Vehicle</b>	<b>Other</b>
<b>1998</b>	846	2.05	579	121	121	25
<b>1999</b>	790	1.87	526	129	115	20
<b>2000</b>	908	2.10	571	176	128	33
<b>Total</b>	2544	2.0	1676	426	346	78

**CRASH DATA – SEVERITY**

<b>Year</b>	<b>Total Crashes</b>	<b>PDO</b>	<b>Injury</b>	<b>Fatal</b>	<b>Truck Involved</b>
<b>1998</b>	846	609	237	0	42
<b>1999</b>	790	558	231	1	49
<b>2000</b>	908	648	259	1	70
<b>Total</b>	2544	1815	727	2	161

## SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

**Observations:** During most observations, northbound congestion was found on I-17 between Thomas Road and Northern Avenue. Congestion appeared to be caused or exacerbated by weaving and merging associated with the interchanges along this corridor. Average estimated speeds typically ranged from approximately 20 to 40 mph.

While congestion persisted north of Northern Avenue, traffic flow typically improved on the approach to Cactus Road; average estimated speeds along this segment typically ranged from 30 to 50 mph.

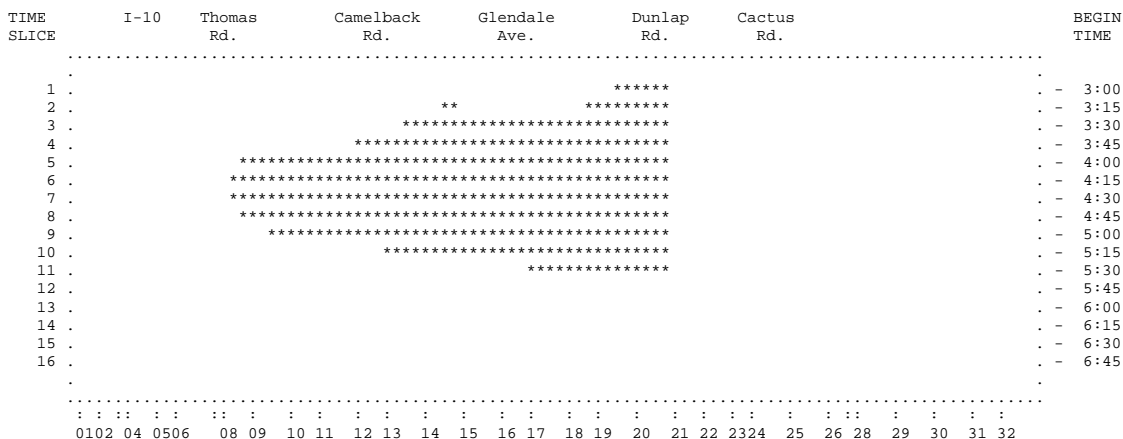
**Density Data:** Level of Service F (density greater than 45 vehicles per lane-mile) between Cactus Road and Dunlap Avenue between 4:00 and 6:00 pm; between Dunlap Avenue and Northern Avenue between 3:30 and 6:00 pm; between Northern Avenue and Bethany Home Road between 4:00 and 6:00 pm; between Bethany Home Road and Camelback Road between 3:30 and 6:00 pm; between Camelback Road and Indian School Road between 4:00 and 6:00 pm; and between Indian School Road and Thomas Road between 3:30 and 6:00 pm.

## FREQ ANALYSIS

**Segment J:** I-17 NB; Van Buren Street to Bell Road; 3:00 to 7:00 pm

**Existing Conditions:** Bottlenecks occur at Peoria Avenue, Dunlap Avenue, and Bethany Home Road.

**Queue Diagram of existing conditions for Segment J:**



**Queue Diagram Key:**

BLANK DENOTES UNCONGESTED TRAFFIC.

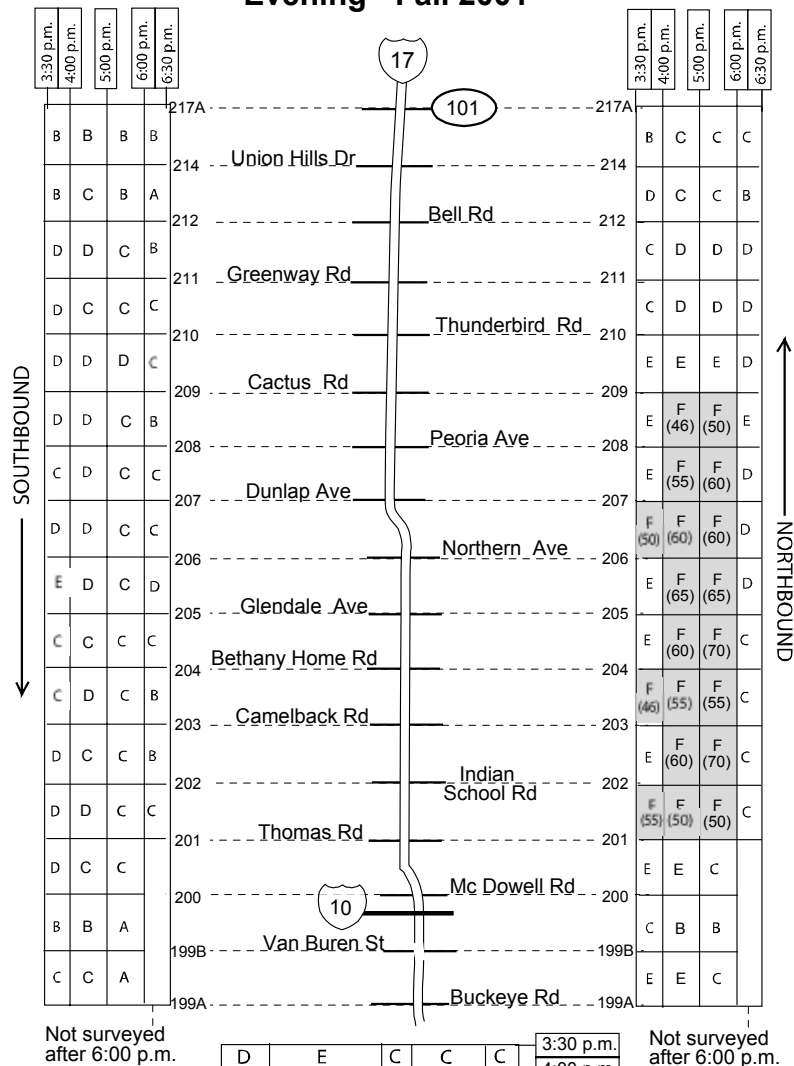
ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

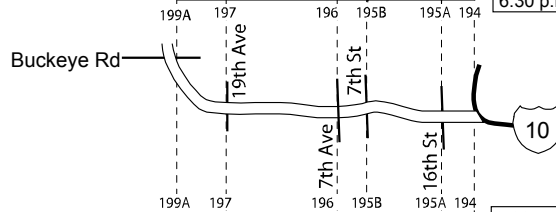
# **I-17** **(Between Loop 101 & I-10)** **Evening - Fall 2001**



Not surveyed after 6:00 p.m.

Not surveyed after 6:00 p.m.

D	E	C	C	C	3:30 p.m.
C	D	D	D	A	4:00 p.m.
B	C	C	C	B	5:00 p.m.
Not surveyed after 6:00 p.m.					6:00 p.m.
Not surveyed after 6:00 p.m.					6:30 p.m.



## **LEVEL-OF-SERVICE LEGEND:**

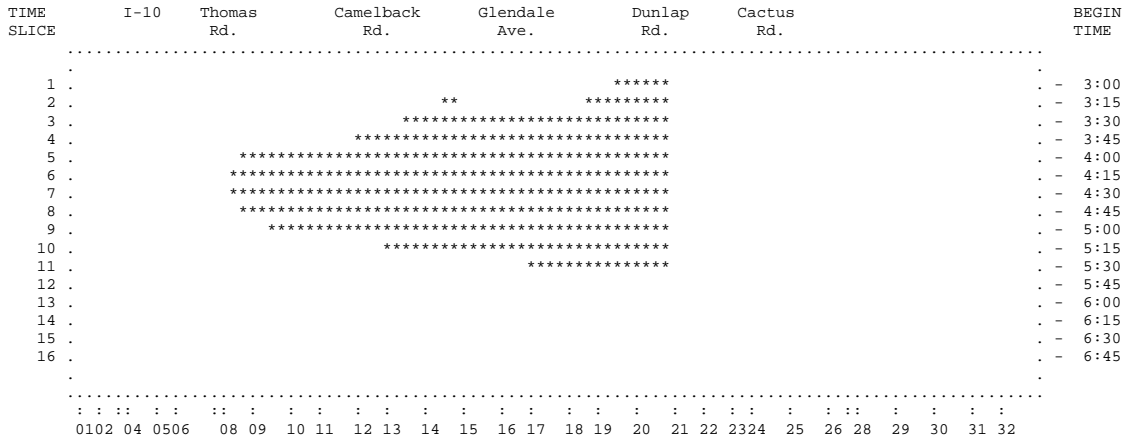
LIGHT		MODERATE		HEAVY		CONGESTED		SEVERE	
A	B	C	D	E	F	F	F	F	F
0	10	20	30	45	65				
Density scale (cars per lane-mile)									
Note: F (60) in the tables means level-of-service "F", with density = 60									

B	B	C	C	B	3:30 p.m.
B	B	C	C	B	4:00 p.m.
B	B	B	C	B	5:00 p.m.
Not surveyed after 6:00 p.m.					6:00 p.m.
Not surveyed after 6:00 p.m.					6:30 p.m.

**Alternative1:** Add auxiliary lanes from Peoria Avenue to Greenway Road.

**Result:** This alternative has no impact on existing congestion.

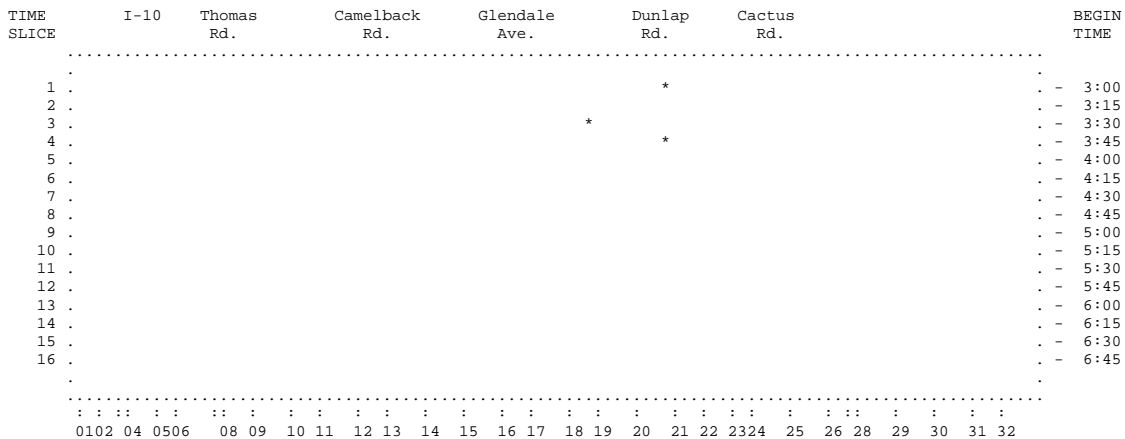
### Queue Diagram of Alternative1 for Segment J:



**Alternative2:** Add ramp metering at 900 vehicles per hour throughout the entire segment.

**Result:** This alternative eliminates mainline congestion, however, it produces long queues and delay at on-ramps. Total freeway travel time increases nearly 45%.

### Queue Diagram of Alternative 2 for Segment J:





## ANALYSIS SUMMARY – SEGMENT J

	<b>Mainline Travel Time (pass-hr)</b>	<b>Ramp Delay (pass-hr)</b>	<b>Total Freeway Travel Time (pass-hr)</b>	<b>Average Speed (mph)</b>
Existing Conditions	6605	1292	7897	39.5
Alternative1	6598	1292	7890	39.5
Alternative2	3667	7779	11446	68.2

### Conclusions/Recommendations:

1. Short of adding a fourth general purpose lane, the addition of auxiliary lanes north of Peoria Avenue does not impact existing congestion.
2. Additional capacity along this section of the I-17 corridor could be achieved by elevating the existing HOV lanes on a structure. Space for light-rail could also be provided on the structure. The existing HOV lane could then be converted to a general purpose lane.

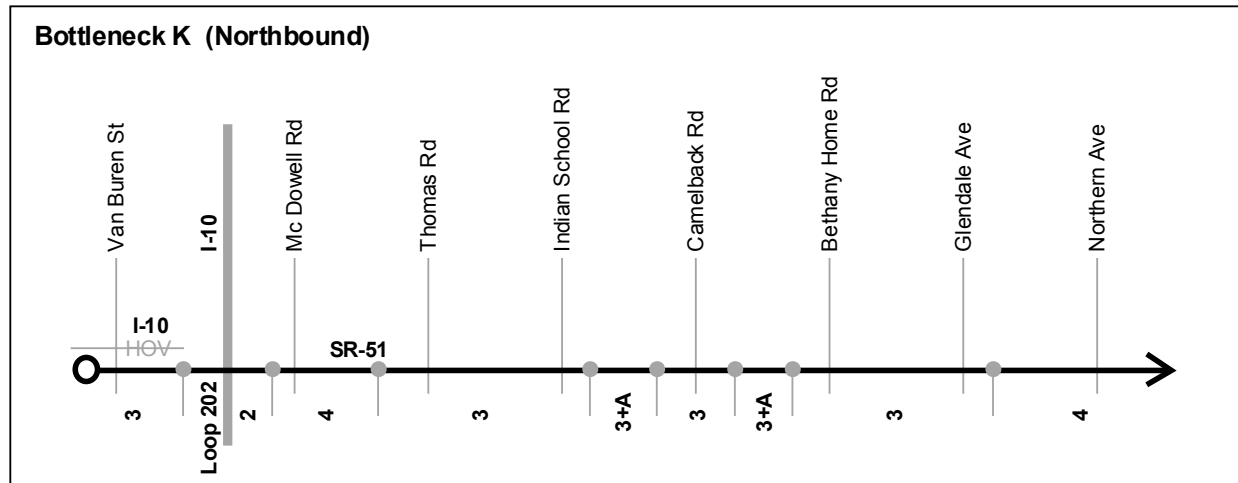
## SEGMENT K

### SR-51 NORTHBOUND: VAN BUREN STREET (ON I-10) TO NORTHERN AVENUE EVENING PEAK PERIOD

#### EXISTING CONDITIONS

##### *Geometrics:*

The following schematic illustrates the lane configuration along the K bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



##### *Daily Traffic Volume, Both Directions:*

Daily traffic volume along the K bottleneck segment reaches a maximum of 168,000 vehicles (vpd) near the intersection of SR-51 and McDowell Rd. The volume at this location during the PM peak hour is 13,500, which represents 8.0 percent of the total daily volume.

##### *Northbound Traffic Volumes:*

The volumes shown in the table below represent northbound counts along the K bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

#### TRAFFIC VOLUMES

Location	PM Peak Hour Total Volume	PM Peak Hour GP Volume	PM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
I-10 / Van Buren St	7,300	6,800	500	8.7%	-----
SR-51 / Oak St	6,600	-----	-----	8.2%	-----
SR-51 / Camelback Rd	6,100	-----	-----	9.8%	-----
SR-51 / Northern Av	8,900	-----	-----	11.5%	-----

## CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

### CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	314	1.55	200	32	69	13
1999	287	1.40	170	36	67	14
2000	283	1.37	158	37	79	9
Total	884	1.44	528	105	215	36

### CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	314	245	69	0	7
1999	287	211	76	0	5
2000	283	211	72	0	4
Total	884	667	217	0	16

## SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

*Observations:* During most observations, northbound congestion was found on SR-51 between I-10 and Indian School Road. The primary bottlenecks appeared to be the lane drop [4 lanes to 3] at Thomas Road, and vehicles entering at Indian School Road. Average speeds along this segment typically ranged from approximately 20 to 30 mph.

While congestion persisted North of Indian School Road, traffic flow generally improved in the approach to Glendale Avenue; average estimated speeds along this segment ranged from approximately 30 to 50 mph. Contributing to the improved flow was the widening of the roadway [3 lanes to 4] at the Glendale Avenue interchange.

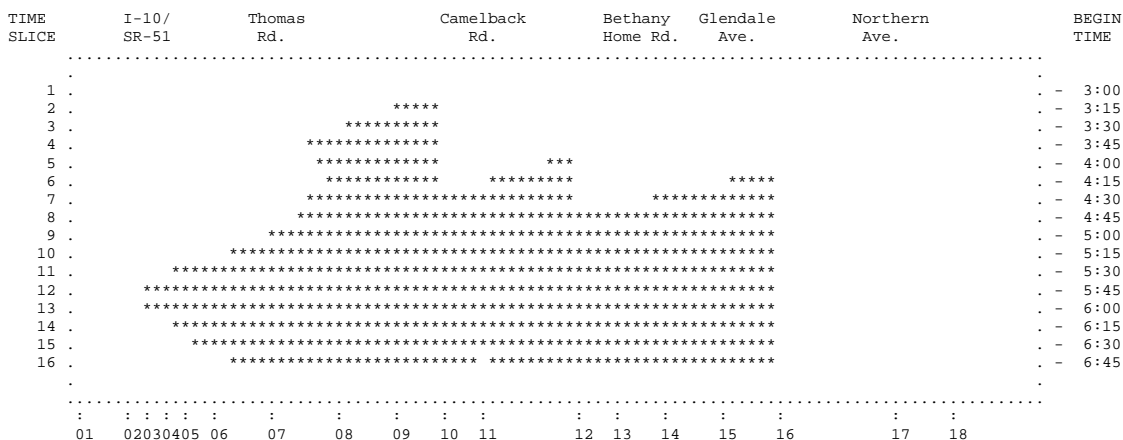
*Density Data:* LOS F (density greater than 45 vehicles per lane-mile) between Glendale Avenue and Bethany Home Road between 3:30 and 4:00 pm and again between 5:00 and 6:00 pm; between Bethany Home Road and Camelback Road between 5:00 and 6:00 pm; between Camelback Road and Indian School Road between 5:00 and 6:30 pm; between Indian School Road and Thomas Road between 4:00 and 6:30 pm; and between Thomas Road and McDowell Road between 4:00 and 6:00 pm.

## FREQ ANALYSIS

### Segment K: SR-51 NB; Van Buren Rd. to Northern Avenue; 3:00 to 7:00 pm

**Existing Conditions:** Bottlenecks exist at Indian School Rd, Camelback Rd, and Glendale Avenue. Congestion is partially a result of the roadway's horizontal and vertical geometry, which results in a lower free-flow speed and capacity.

### Queue Diagram of Existing Conditions for Segment K:



#### Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

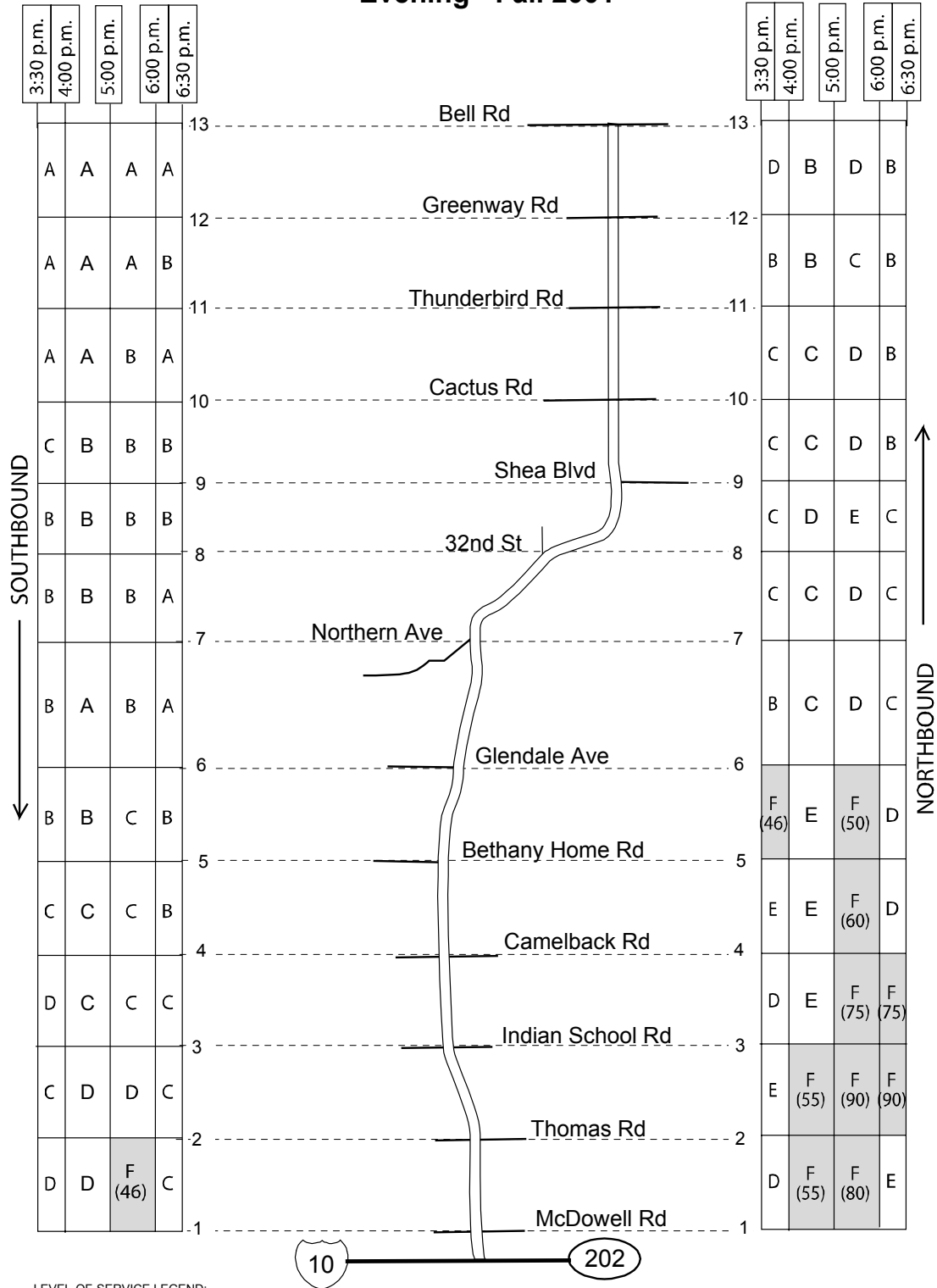
ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

# SR 51 Evening - Fall 2001



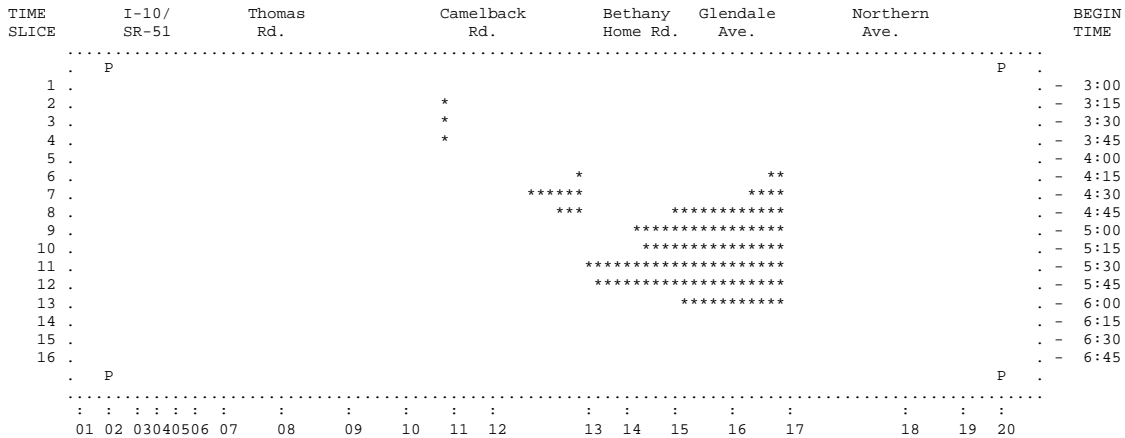
LEVEL-OF-SERVICE LEGEND:

LIGHT	MODERATE	HEAVY	CONGESTED	SEVERE
A	B	C	D	E
0	10	20	30	45
Density scale (cars per lane-mile)				
Note: F (60) in the tables means level-of-service "F", with density = 60				

**Alternative1:** Add an HOV lane to this segment. For modeling purposes, it was assumed that 10% of the traffic contains 2 or 3+ passengers and thus can use the HOV lane.

**Result:** The model suggests that an HOV lane will result in a significant reduction in congestion. This may be an overstatement. Overall freeway travel time is projected to decrease 14%.

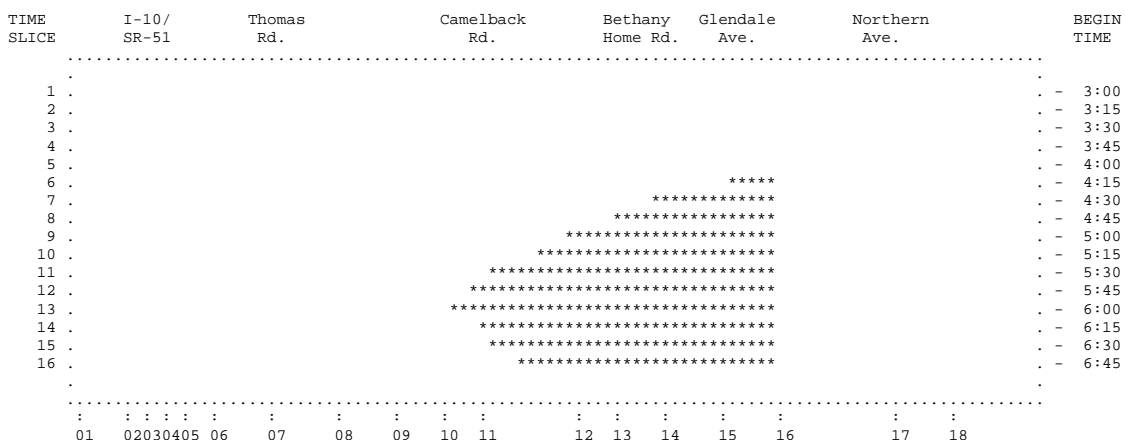
**Queue Diagram of Alternative1 for Segment K:**



**Alternative2:** Add a general purpose lane from McDowell Road to Glendale Avenue. Add an auxiliary lane from Glendale Avenue to Northern Avenue, with a two-lane on-ramp at Glendale Avenue. This alternative does not include an HOV lane.

**Result:** Eliminates all existing congestion. Overall freeway travel time decreases 16%.

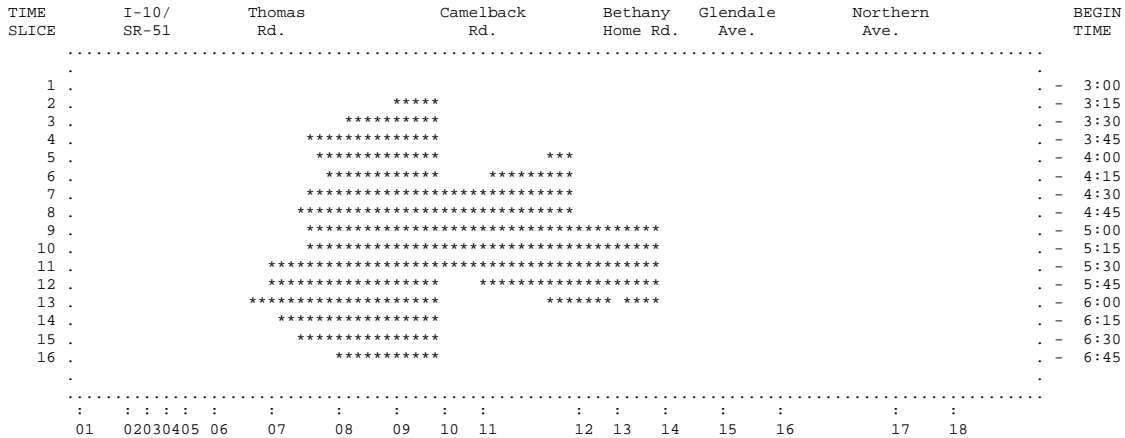
**Queue Diagram of Alternative2 for Segment K:**



**Alternative3:** Add an auxiliary lane from Glendale Avenue to Northern Avenue and a two-lane on-ramp at Glendale Avenue.

**Result:** Reduces congestion caused by the bottleneck at Glendale Avenue. The bottleneck at Indian School Road is not affected. Overall freeway travel time decreases 10%.

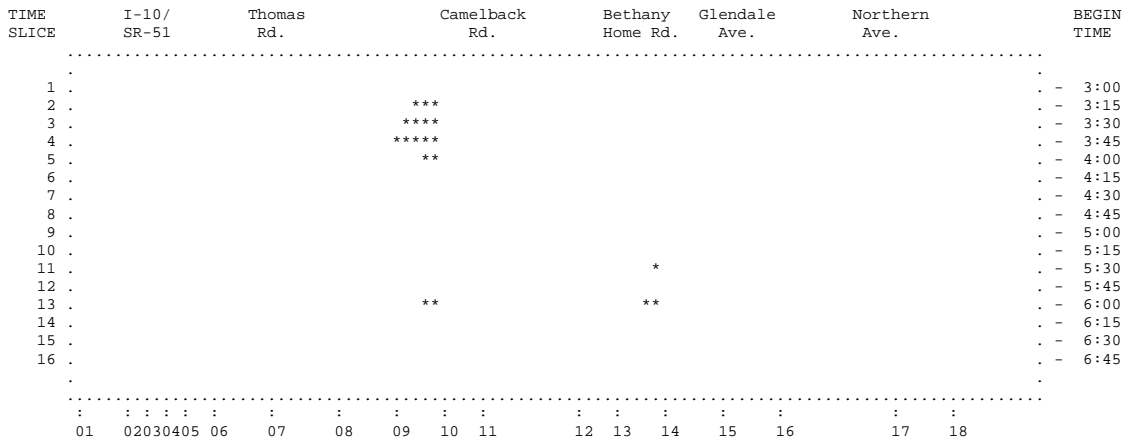
**Queue Diagram of Alternative3 for Segment K:**



**Alternative4:** Add ramp metering at 900 vehicles per hour throughout the segment.

**Result:** Greatly reduces mainline congestion, but produces significant queuing on some of the on-ramps. Overall freeway travel time increases 15%.

**Queue Diagram of Alternative4 for Segment K:**



## ANALYSIS SUMMARY – SEGMENT K

	<b>Mainline Travel Time (pass-hr)</b>	<b>Ramp Delay (pass-hr)</b>	<b>Total Freeway Travel Time (pass-hr)</b>	<b>Average Speed (mph)</b>
Existing Conditions	6801	15572	22372	30.9
Alternative1	3477	15797	19274	56.0
Alternative2	5687	15572	21239	37.7
Alternative3	5297	14619	19916	40.7
Alternative4	3246	22597	25843	63.2

### Conclusions/Recommendations:

1. Adding the planned HOV lane will improve existing traffic flow on this section of SR-51, however, probably not to the degree predicted by the freeway model in this analysis.
2. Widening the freeway to a 4+A cross-section from McDowell Road to Glendale Avenue and adding an auxiliary lane from Glendale Avenue to Northern Avenue will significantly reduce congestion. The addition of just the auxiliary lane from Glendale Avenue to Northern Avenue, including a two-lane on-ramp at Glendale Avenue will provide appreciable benefit to traffic flow.
3. Stricter ramp metering can improve traffic flow on the mainline, however, additional storage will be required at each on-ramp.

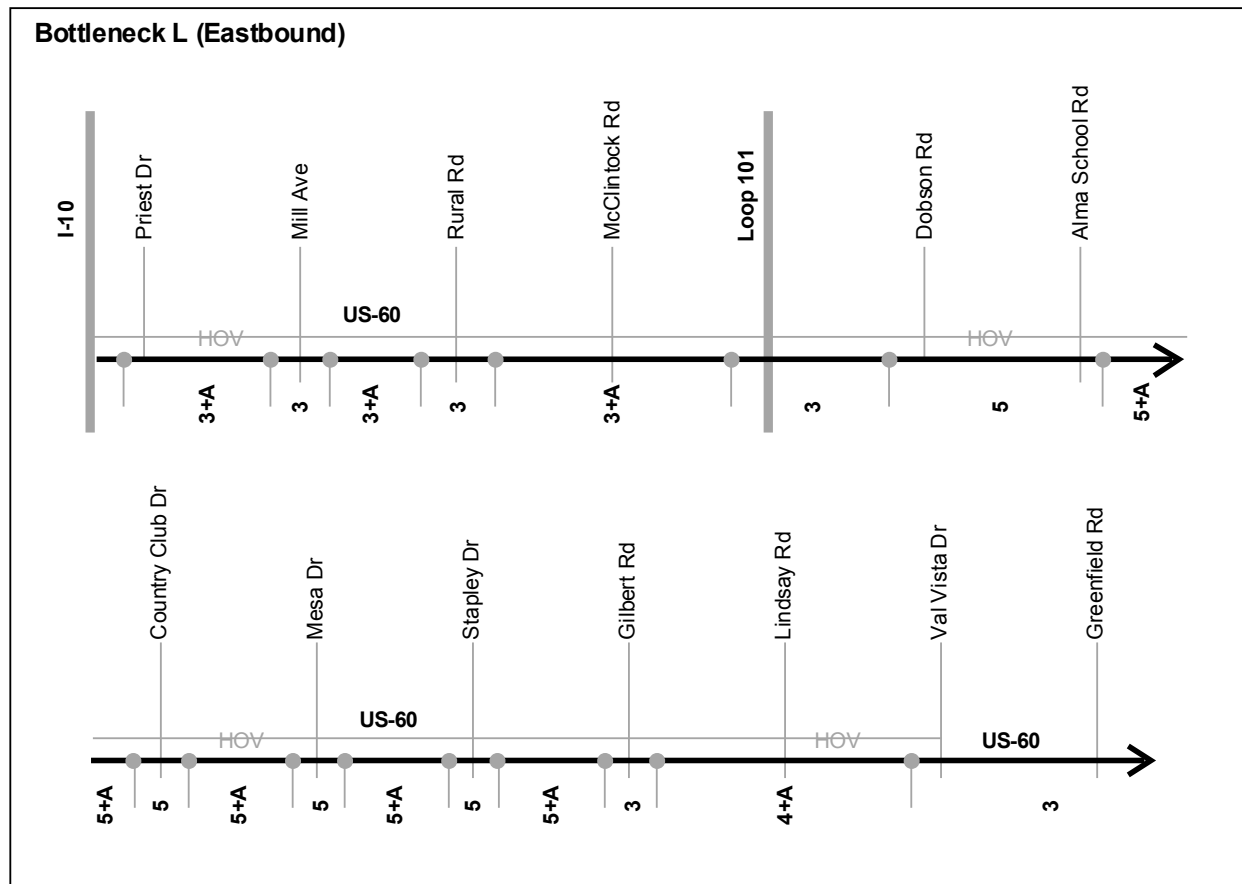


**SEGMENT L**  
**US-60 EASTBOUND: I-10 TO GREENFIELD ROAD**  
**EVENING PEAK PERIOD**

**EXISTING CONDITIONS**

*Geometrics:*

The following schematic illustrates the lane configuration along the L bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



*Daily Traffic Volume, Both Directions:*

Daily traffic volume along the L bottleneck segment reaches a maximum of 176,000 vehicles (vpd) near the intersection of US-60 and Mesa Dr. . The volume at this location during the PM peak hour is 11,600, which represents 6.6% of the total daily volume.

*Eastbound Traffic Volumes:*

The volumes shown in the table below represent eastbound counts along the L bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

**TRAFFIC VOLUMES**

<b>Location</b>	<b>PM Peak Hour Total Volume</b>	<b>PM Peak Hour GP Volume</b>	<b>PM Peak Hour HOV Volume</b>	<b>Percent Peak Hour</b>	<b>Percent Peak Hour Trucks</b>
US-60 / Priest Dr	6,200	-----	-----	7.7%	0.5%
US-60 / Mesa Dr	6,100	-----	-----	7.0%	1.2%
US-60 / /Gilbert Rd	5,700	-----	-----	7.8%	-----
US-60 / Greenfield Rd	5,300	-----	-----	7.0%	-----

**CRASH DATA**

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

**CRASH DATA – COLLISION TYPE**

<b>Year</b>	<b>Total Crashes</b>	<b>Crash Rate</b>	<b>Rear End</b>	<b>Sideswipe</b>	<b>Single Vehicle</b>	<b>Other</b>
<b>1998</b>	684	2.11	452	76	134	22
<b>1999</b>	754	2.28	508	108	107	31
<b>2000</b>	641	1.90	450	87	85	19
<b>Total</b>	2079	2.10	410	271	326	72

**CRASH DATA – SEVERITY**

<b>Year</b>	<b>Total Crashes</b>	<b>PDO</b>	<b>Injury</b>	<b>Fatal</b>	<b>Truck Involved</b>
<b>1998</b>	684	477	206	1	24
<b>1999</b>	754	554	200	0	32
<b>2000</b>	641	455	184	2	26
<b>Total</b>	2079	1486	590	3	82

## SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

*Observations:* During the peak period, eastbound congestion was found on US-60 from the vicinity of I-10 to McClintock Drive; average estimated speeds along this segment typically ranged from approximately 10 to 30 mph. Ongoing construction (right shoulder closed) between I-10 and McClintock Drive may have exacerbated the congestion.

During the peak period, eastbound congestion was found on US-60 between Loop 101 and Country Club Drive. Ongoing construction (right shoulder closed) between Dobson Road and Val Vista Drive may have exacerbated the congestion. Average speeds along this segment typically ranged from approximately 15 to 25 mph.

While congestion persisted east of Country Club Drive, traffic flow typically improved in the approach to Lindsay Road; average estimated speeds along the corridor typically ranged from approximately 35 to 45 mph.

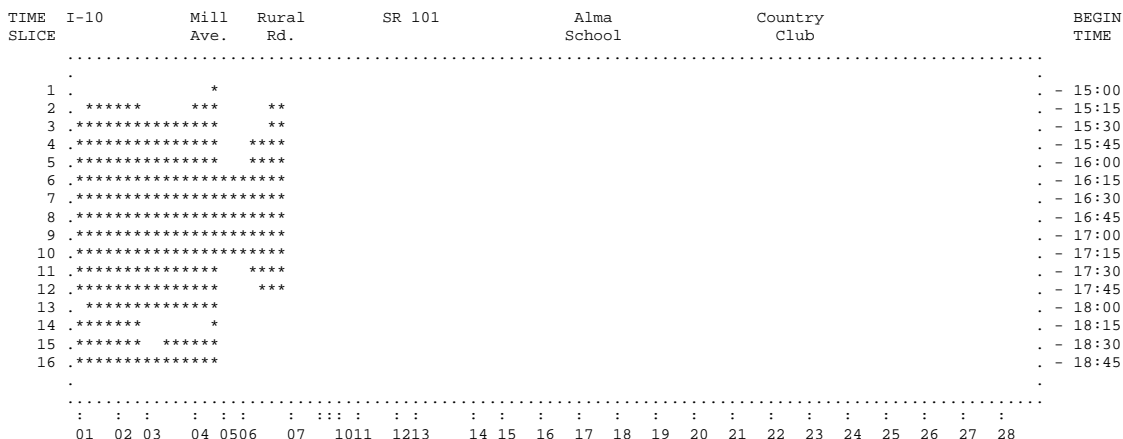
*Density Data:* Level of Service F (density greater than 45 vehicles per lane-mile) westbound between Mesa Drive and Stapely Drive between 3:00 and 4:00 pm. Level of Service F eastbound between I-10 and Priest Drive between 5:00 and 6:00 pm; between Preist Drive and McClintock Drive between 3:30 and 6:30 pm; between Loop 101 and Dobson Road between 3:30 and 4:00, and again between 6:00 and 6:30 pm; between Dobson Road and Country Club Drive between 3:30 and 6:30 pm; between Country Club Drive and Mesa Drive between 4:00 and 6:30 pm; and between Mesa Drive and Lindsay Road between 5:00 and 6:00 pm.

## FREQ ANALYSIS

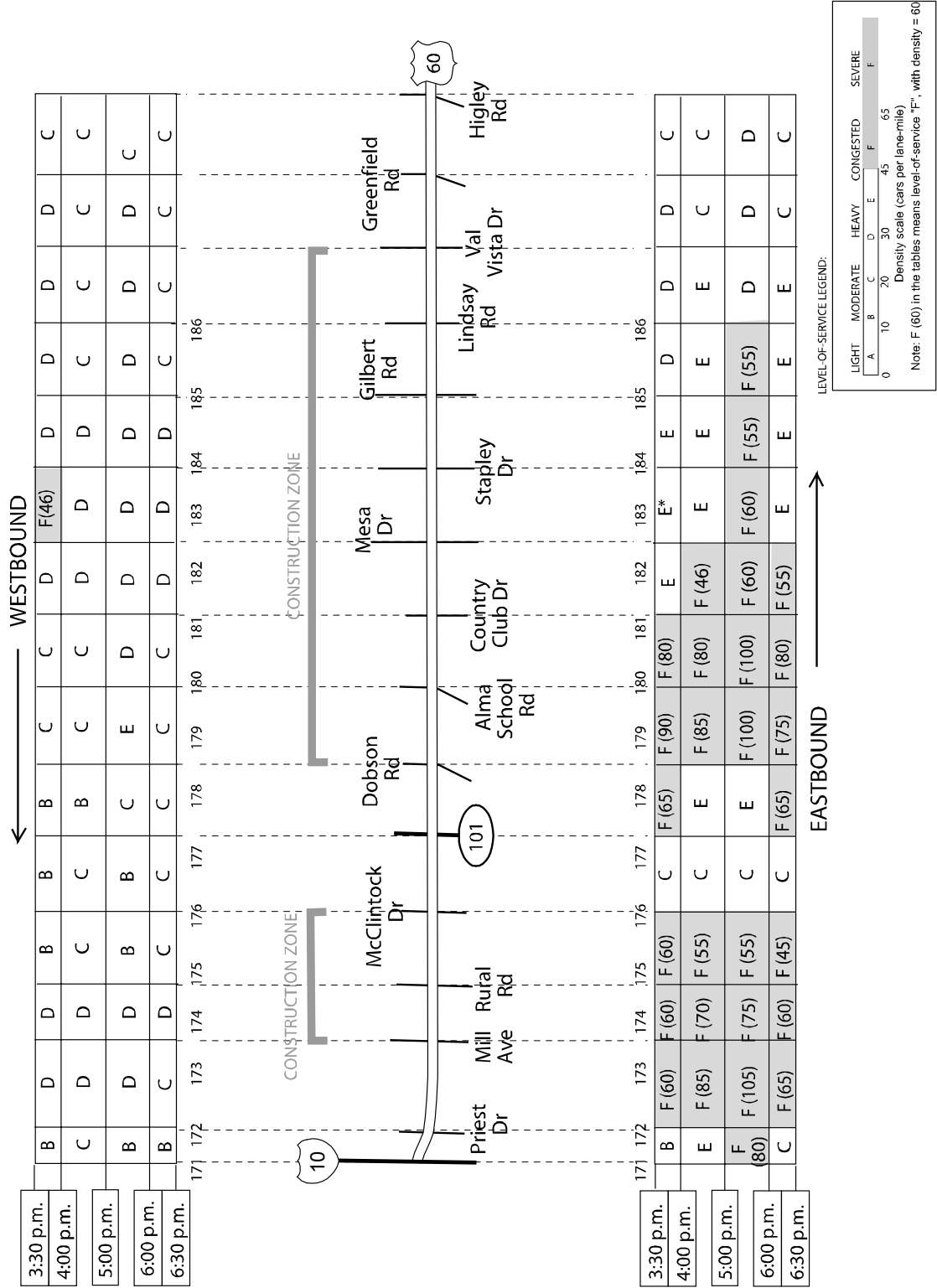
### Segment L: US-60 EB; I-10 to Greenfield Road; 3:00 to 7:00 pm

**Existing Conditions:** Bottlenecks currently occur at Mill Avenue and Rural Road. Since traffic data for this freeway segment was collected during construction, it was not possible to develop an accurate model of existing conditions. The existing conditions model developed for this segment includes the new freeway geometry and lane configuration that is under construction. This includes a cross-section of 3+1 within the City of Tempe and 5+1+A from the Loop 101 interchange to Power Road.

### Queue Diagram of Existing Conditions for Segment L:



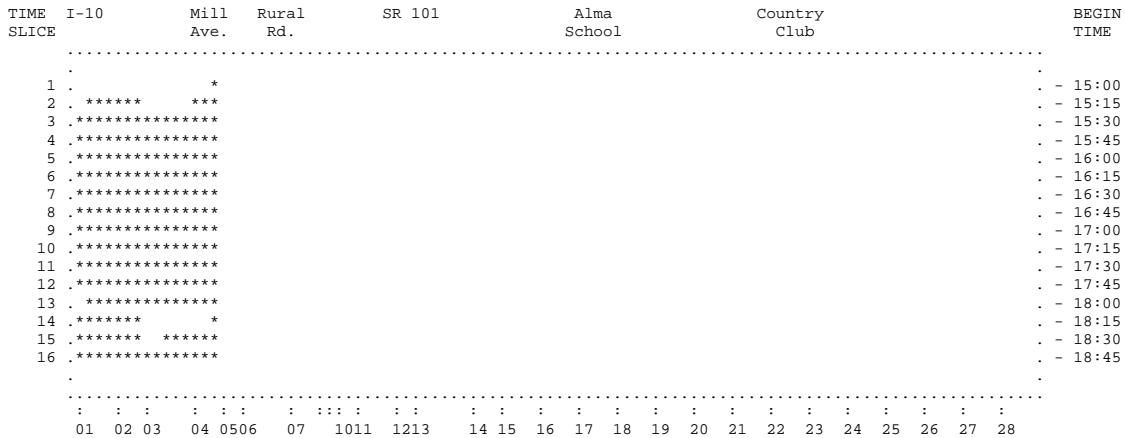
# US Route 60 (Between I-10 & Higley Rd) Evening - Fall 2001



**Alternative1:** Add auxiliary lanes from I-10 to Loop 101. These additions are going to be included in the current construction.

**Result:** This alternative eliminates the Rural Road bottleneck, however, the bottleneck at Mill Avenue remains. Overall freeway travel time decreases 4%.

### Queue Diagram of Alternative1 for Segment L:



### ANALYSIS SUMMARY – SEGEMENT L

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	6696	2019	8714	48.6
Alternative1	6418	2006	8424	50.8

### Conclusions/Recommendations:

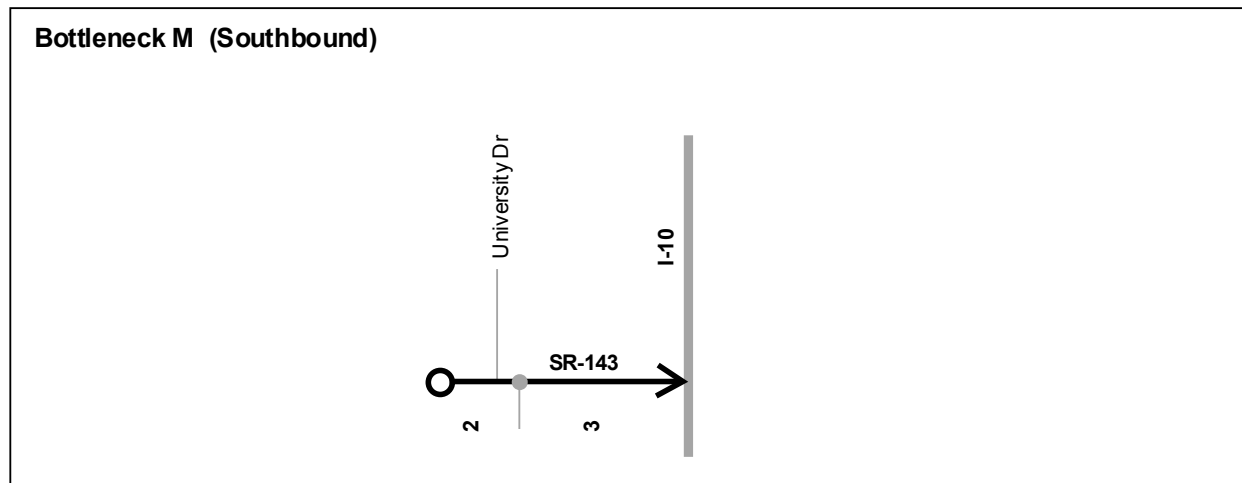
Although an accurate model of existing conditions on this freeway section could not be developed, the evaluation of conditions with the on-going construction project complete, including auxiliary lanes from I-10 to Loop 101, indicates that the bottleneck at Mill Avenue will create congestion that will likely back onto the northbound to eastbound I-10 to US-60 connector-ramp. Additional through lane capacity is needed on the section of US-60 from I-10 to Loop 101.

**SEGMENT M**  
**SR-143 SOUTHBOUND: UNIVERSITY DRIVE TO I-10**  
**EVENING PEAK PERIOD**

**EXISTING CONDITIONS**

*Geometrics:*

The following schematic illustrates the lane configuration along the M bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



*Daily Traffic Volume, Both Directions:*

Daily traffic volume along the M bottleneck segment reaches a maximum of 69,000 vehicles (vpd) at the intersection of SR-143 and University Dr. The volume at this location during the PM peak hour is 5,400, which represents 7.8% of the total daily volume.

*Southbound Traffic Volumes:*

The volumes shown in the table below represent southbound counts along the M bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

**TRAFFIC VOLUMES**

Location	PM Peak Hour Total Volume	PM Peak Hour GP Volume	PM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
SR-143 / University Dr	2,700	-----	-----	7.9%	-----

## CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

### CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	26	2.00	22	5	0	0
1999	21	1.61	16	3	2	0
2000	18	1.38	17	0	0	1
Total	65	1.66	55	7	2	1

### CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	26	23	3	0	0
1999	21	18	3	0	0
2000	18	10	8	0	0
Total	65	51	14	0	0

## SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

*Observations:* During the peak period, congestion was typically found on the southbound on-ramp at University Drive; when congested, queue populations at the ramp meter ranged from approximately 80 to 90 vehicles (one thru-lane at the ramp meter).

During the peak period, congestion was typically found on the off-ramp to I-10 (eastbound); at its maximum observed extent, the queue extended back into the right lane of SR-143.

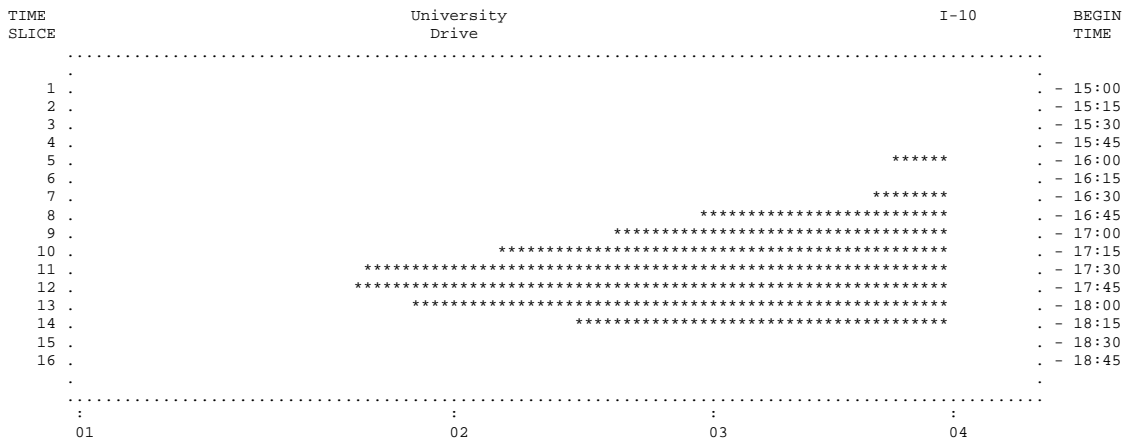
*Density Data:* Level of Service F (density greater than 45 vehicles per lane-mile) between University Drive and I-10 between 5:00 and 6:00 pm.

## FREQ ANALYSIS

**Segment M: SR-143 SB; University Dr. to I-10; 3:00 to 7:00 pm**

**Existing Conditions:** The bottleneck at the I-10/SR-143 interchange is caused by congestion on the right-side loop ramp and the traffic signal at the Broadway Road on-ramp to I-10.

### Queue Diagram of existing conditions for Segment M:



#### Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

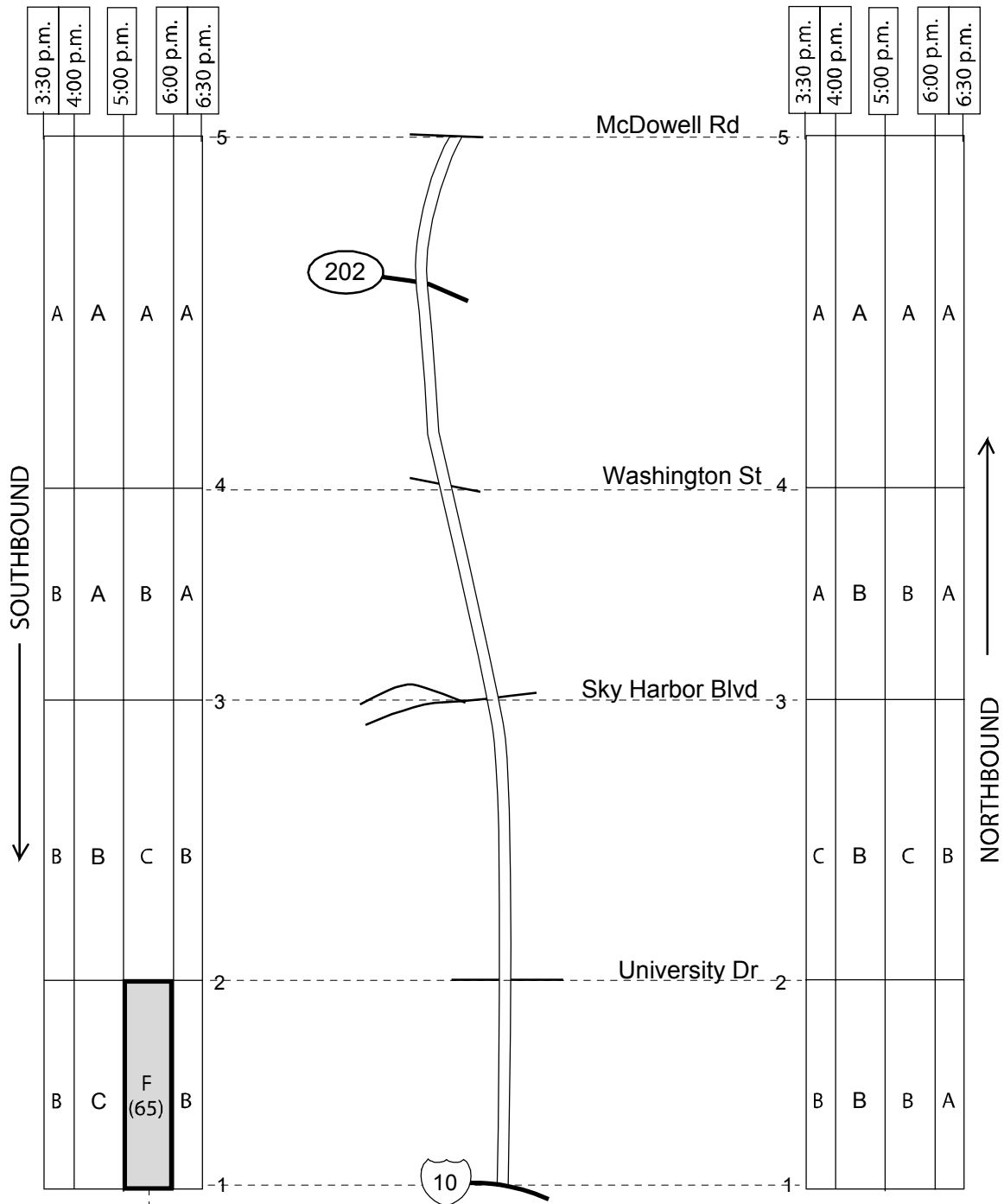
M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).



# SR 143 Evening - Fall 2001



These level-of-service ratings represent the mathematical average of densities, which varied widely between the right- and left-hand lanes. When congested, densities in the right lane approaching I-10 were as high as 80 pcplpm with corresponding speed estimates of 20 to 25 mph.

## LEVEL-OF-SERVICE LEGEND:

LIGHT		MODERATE		HEAVY		CONGESTED		SEVERE	
A	B	C	D	E	F	F	F	F	F
0	10	20	30	45	65	65	65	65	65
Density scale (cars per lane-mile)									
Note: F (60) in the tables means level-of-service "F", with density = 60									

**Conclusions/Recommendations:**

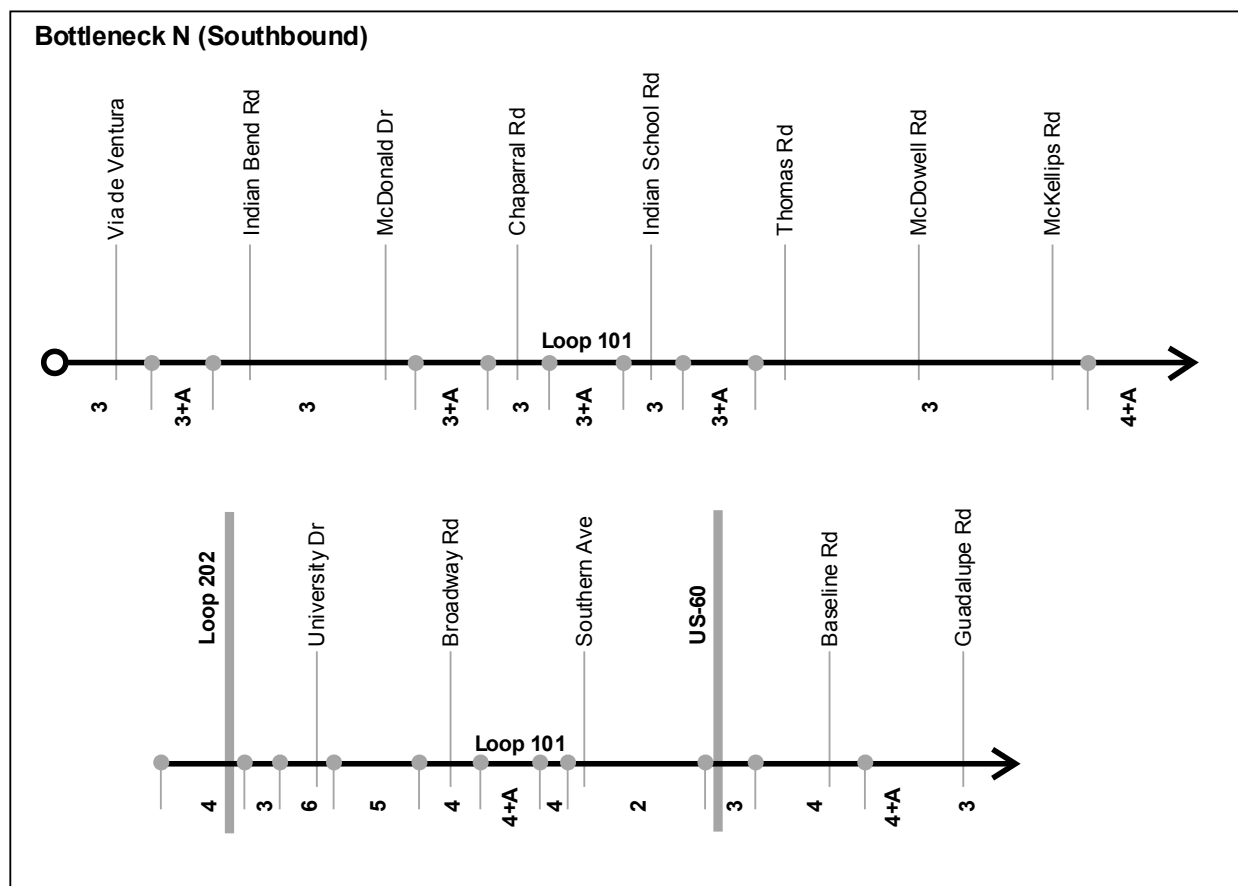
1. The planned collector-distributor road on this section of I-10 will eliminate the direct ramp connections between SR-143 and I-10. Instead, SR-143 will connect to the collector-distributor road and traffic destined for I-10 will enter the freeway at Baseline Road. A detailed evaluation of the impacts of the collector-distributor road on SR-143 traffic operations is needed.

# **SEGMENT N** **LOOP 101 SOUTHBOUND: VIA DE VENTURA TO GUADALUPE ROAD** **EVENING PEAK PERIOD**

## **EXISTING CONDITIONS**

### *Geometrics:*

The following schematic illustrates the lane configuration along the N bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



### *Daily Traffic Volume, Both Directions:*

Daily traffic volume along the N bottleneck segment reaches a maximum of 192,000 vehicles (vpd) near the intersection of Loop 101 and Southern Ave. The volume at this location during the PM peak hour is 14,000, which represents 7.3% of the total daily volume.

*Southbound Traffic Volumes:*

The volumes shown in the table below represent southbound counts along the N bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

**TRAFFIC VOLUMES**

<b>Location</b>	<b>PM Peak Hour Total Volume</b>	<b>PM Peak Hour GP Volume</b>	<b>PM Peak Hour HOV Volume</b>	<b>Percent Peak Hour</b>	<b>Percent Peak Hour Trucks</b>
Loop 101 / McDonald Dr	4,000	-----	-----	8.2%	-----
Loop 101 / Indian School Rd	5,700	-----	-----	8.1%	-----
Loop 101 / Thomas Rd	7,000	-----	-----	8.2%	-----
Loop 101 / McKellips Rd	6,800	-----	-----	7.5%	-----
Loop 101 / 8 <sup>th</sup> St	8,100	-----	-----	6.9%	-----
Loop 101 / Southern Ave	7,700	-----	-----	6.4%	0.4%

**CRASH DATA**

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

**CRASH DATA – COLLISION TYPE**

<b>Year</b>	<b>Total Crashes</b>	<b>Crash Rate</b>	<b>Rear End</b>	<b>Sideswipe</b>	<b>Single Vehicle</b>	<b>Other</b>
<b>1998</b>	83	0.42	51	6	21	5
<b>1999</b>	124	0.46	57	18	31	18
<b>2000</b>	276	0.82	137	51	71	17
<b>Total</b>	483	0.57	245	75	123	40

**CRASH DATA – SEVERITY**

<b>Year</b>	<b>Total Crashes</b>	<b>PDO</b>	<b>Injury</b>	<b>Fatal</b>	<b>Truck Involved</b>
<b>1998</b>	83	66	16	1	1
<b>1999</b>	124	85	37	2	6
<b>2000</b>	276	198	76	1	7
<b>Total</b>	483	348	130	4	14

## SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

**Observations:** During the peak period, an extended zone of southbound congestion was found on Loop 101 between Via de Ventura (five miles north of Thomas Road) and McDowell Road. Congestion appeared to be caused or exacerbated by weaving and merging associated with the interchanges along this corridor. Average estimated speeds ranged widely, from approximately 15 to 45 mph.

While congestion persisted south of McDowell Road, traffic flow typically improved on the approach to McKellips Road; average estimated speeds along this segment ranged from approximately 35 to 50 mph. Contributing to the improved flow was the widening of the roadway (3 lanes to 4) at McKellips Road.

During the peak period, southbound congestion was found on Loop 101 between Loop 202 and US- 60; average estimated speeds along this segment typically ranged from approximately 30 to 45 mph. Factors contributing to the congestion were 1) the lane drop [5 lanes to 4] at Broadway Road and 2) the lane drop [4 lanes to 2] at the US-60 interchange.

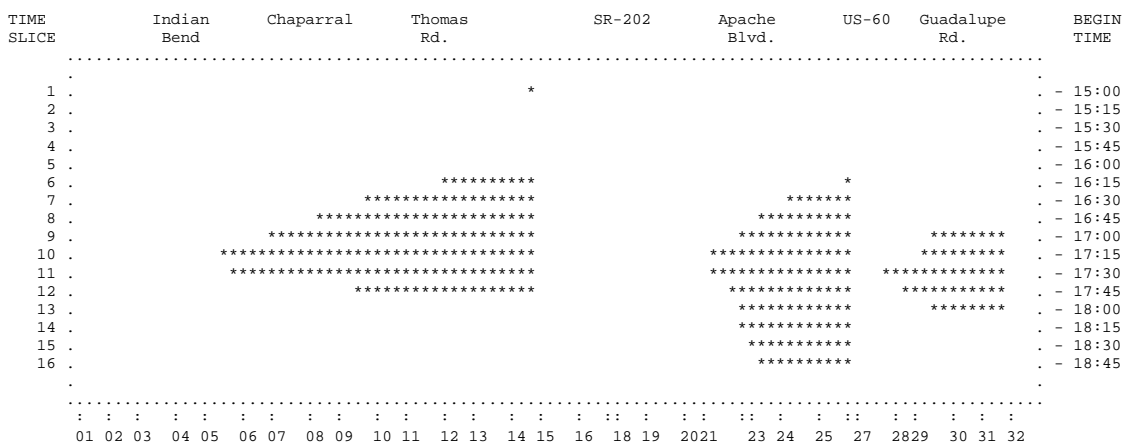
**Density Data:** Level of Service F (density greater than 45 vehicles per lane-mile) southbound between McDowell Road and McKellips Road between 3:30 and 6:00 pm; between University Drive and Southern Avenue between 5:00 and 6:30 pm; and between Southern Avenue and the US-60 interchange between 4:00 and 6:30 pm.

## FREQ ANALYSIS

**Segment N:** Loop 101 SB; Via de Ventura to Guadalupe Rd; 3:00 to 7:00 pm

**Existing Conditions:** Existing bottlenecks occur at McDowell Road, the US-60 interchange, and Guadalupe Road.

### Queue Diagram of Existing Conditions for Segment N:



#### Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

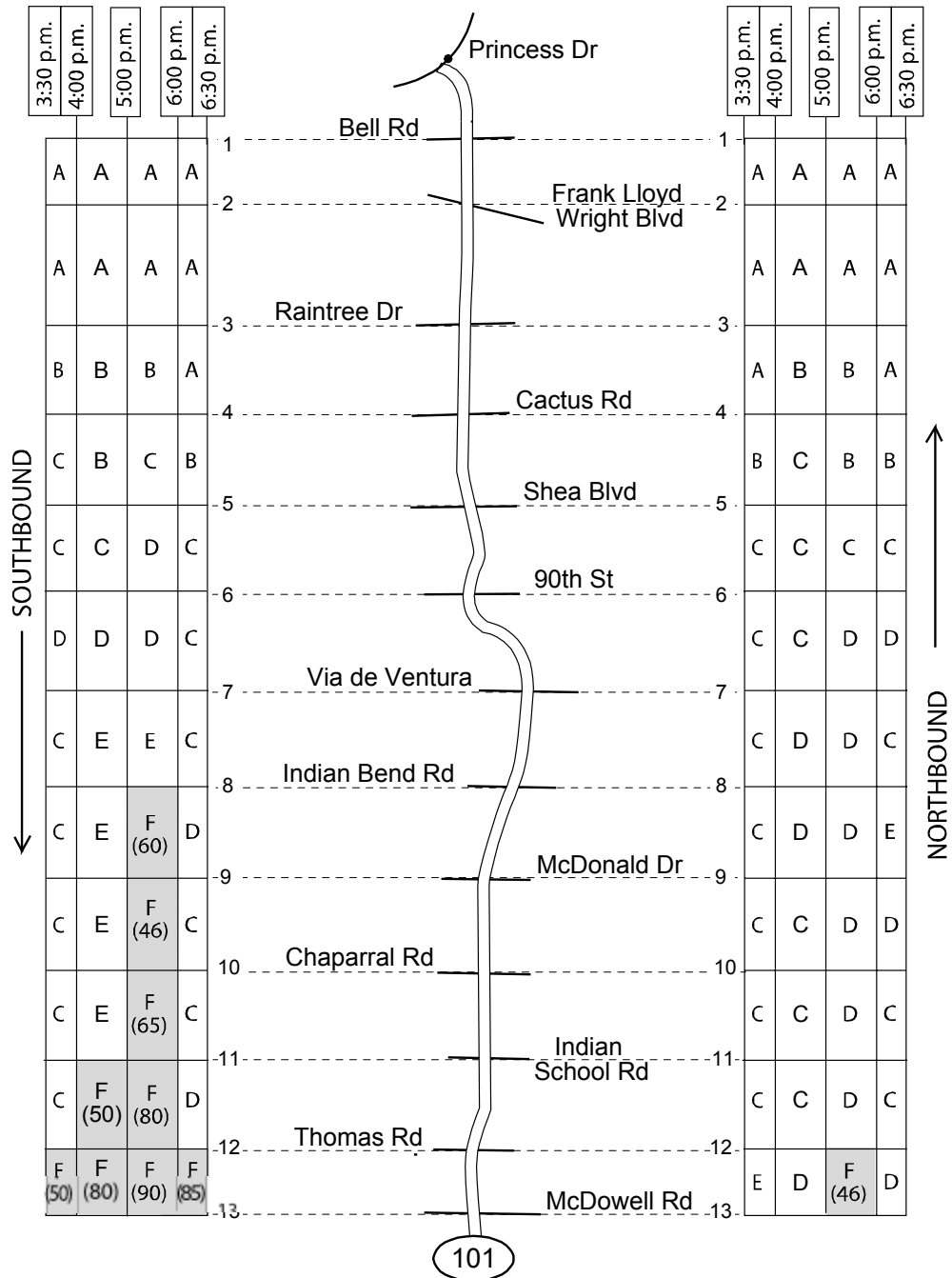
ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

# **Loop 101-Pima Freeway** **(Between Princess Dr & McDowell Rd)** **Evening - Fall 2001**



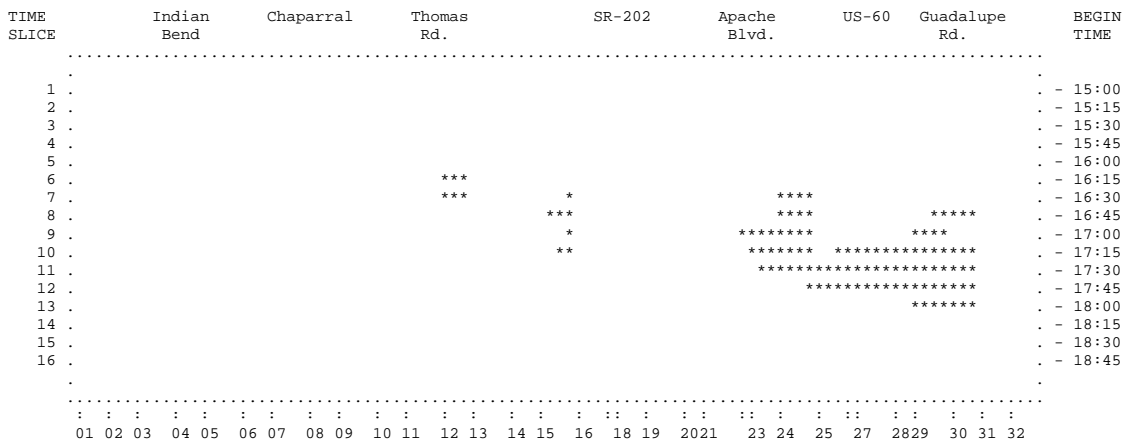
LEVEL-OF-SERVICE LEGEND:

LIGHT	MODERATE	HEAVY	CONGESTED	SEVERE
A	B	C	D	E
0	10	20	30	45
Density scale (cars per lane-mile)				
Note: F (60) in the tables means level-of-service "F", with density = 60				

**Alternative1:** Add auxiliary lanes from Thomas Road to McKellips Road and include a third through lane across the US-60 interchange.

**Result:** This alternative significantly reduced congestion at the McDowell Road bottleneck. Adding the third lane through the US-60 interchange reduced the congestion somewhat. Overall, freeway travel time decreases 26%.

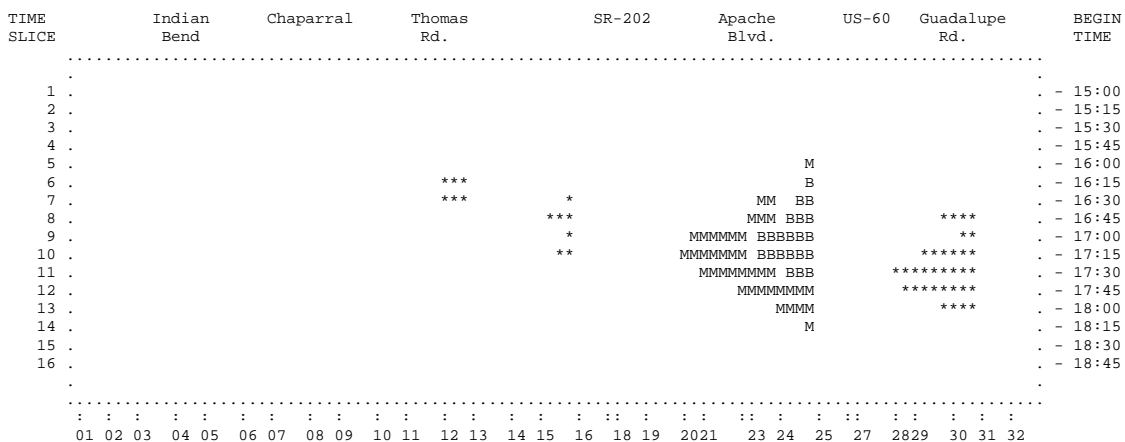
**Queue Diagram of Alternative1 for Segment N:**



**Alternative2:** Add a fifth general purpose lane from the Loop 202 on ramp to the US-60 off-ramp with a mandatory two-lane exit at US-60.

**Result:** This significantly reduced congestion at the McDowell Road bottleneck, but creates a merging problem at the US-60 interchange. Overall, freeway travel time decreases 26%.

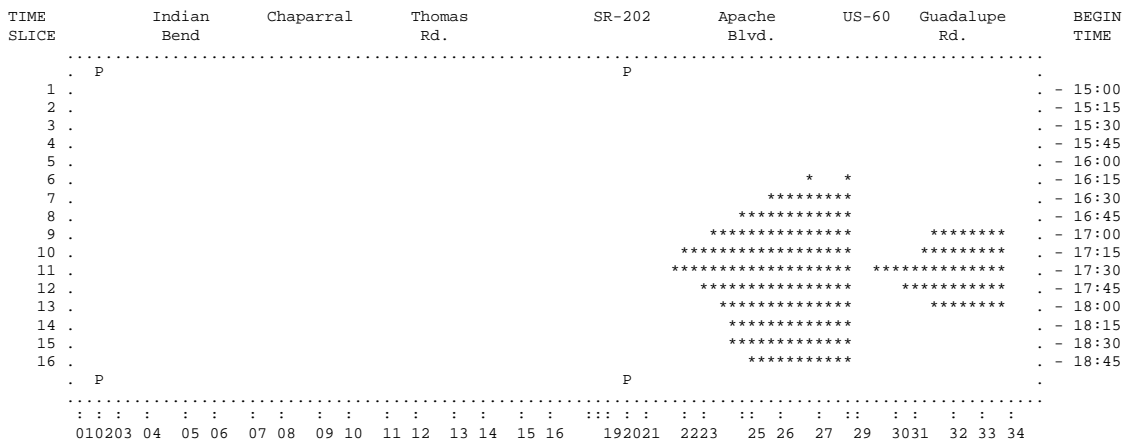
**Queue Diagram of Alternative2 for Segment N:**



**Alternative3:** Add an HOV lane to this segment. For modeling purposes it was assumed that 10% of the traffic contains 2 or 3+ passengers and thus can use the HOV lane. This does not include the addition of any other physical improvements.

**Result:** This alternative eliminates congestion at the McDowell Road bottleneck, however, does not improve conditions downstream. Overall, freeway travel time decreases 15%.

**Queue Diagram of Alternative3 for Segment N:**



### ANALYSIS SUMMARY – SEGMENT N

	Mainline Travel Time (pass-hr)	Ramp Delay (pass-hr)	Total Freeway Travel Time (pass-hr)	Average Speed (mph)
Existing Conditions	7255	0	7255	41.3
Alternative1	5352	0	5352	56.5
Alternative2	5138	267	5405	58.7
Alternative3	6200	0	6200	43.1

### Conclusions/Recommendations:

1. Adding auxiliary lanes from Thomas Road to McKellips Road and a third general-purpose lane through the US-60 interchange will significantly reduce congestion. A four-lane cross section will be required east of Guadalupe Road
2. An HOV lane may benefit traffic flow within this freeway section, however, the level of improvement will depend upon the amount of traffic entering or exiting the HOV lane within the freeway section between Loop 202 and US-60. Significant weaving associated with the HOV lane will impact overall mainline flow.

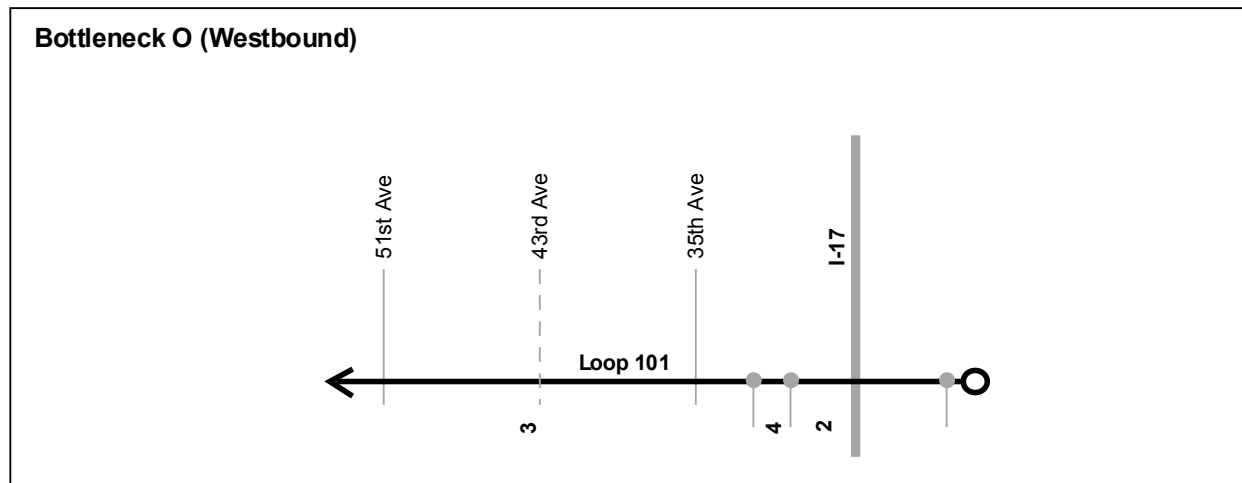


# **SEGMENT O** **LOOP 101 WESTBOUND: I-17 TO 51<sup>ST</sup> AVENUE** **EVENING PEAK PERIOD**

## **EXISTING CONDITIONS**

### *Geometrics:*

The following schematic illustrates the lane configuration along the O bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



### *Daily Traffic Volume, Both Directions:*

Daily traffic volume along the O bottleneck segment reaches a maximum of 124,000 vehicles (vpd) near the intersection of Loop 101 and 43<sup>rd</sup> Ave. The volume at this location during the PM peak hour is 10,400, which represents 8.4% of the total daily volume.

### *Westbound Traffic Volumes:*

The volumes shown in the table below represent westbound counts along the O bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

## **TRAFFIC VOLUMES**

Location	PM Peak Hour Total Volume	PM Peak Hour GP Volume	PM Peak Hour HOV Volume	Percent Peak Hour	Percent Peak Hour Trucks
Loop 101 / 35 <sup>th</sup> Av	6,500	-----	-----	10.2%	-----

## CRASH DATA

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

### CRASH DATA – COLLISION TYPE

Year	Total Crashes	Crash Rate	Rear End	Sideswipe	Single Vehicle	Other
1998	8	0.20	3	1	4	0
1999	30	0.61	4	6	12	8
2000	32	0.55	10	4	16	2
Total	70	.045	17	11	32	10

### CRASH DATA – SEVERITY

Year	Total Crashes	PDO	Injury	Fatal	Truck Involved
1998	8	6	2	0	0
1999	30	22	8	0	4
2000	32	24	8	0	1
Total	70	52	18	0	5

## SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following page.

**Observations:** During most observations, westbound congestion was typically found on Loop 101 (Agua Fria Freeway) between I-17 and 51<sup>st</sup> Avenue; average estimated speeds typically ranged from approximately 30 to 50 mph. Congestion appeared to be caused or exacerbated by weaving and merging associated with the interchanges along the corridor.

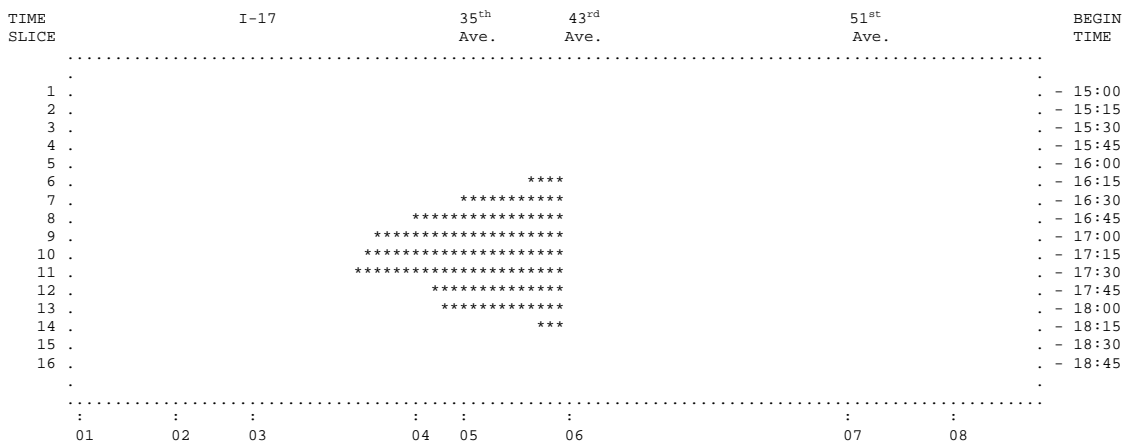
**Density Data:** Level of Service F (density greater than 45 vehicles per lane-mile) westbound between 43<sup>rd</sup> Avenue and 35<sup>th</sup> Avenue between 4:00 and 6:30 pm.

## FREQ ANALYSIS

**Segment O: Loop 101 WB; I-17 to 51<sup>st</sup> Avenue; 3:00 to 7:00 pm**

**Existing Conditions:** An existing bottleneck occurs at 43<sup>rd</sup> Avenue as a result of the heavy traffic volumes from I-17 and 35<sup>th</sup> Avenue.

**Queue Diagram of Existing Conditions for Segment O:**



### Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

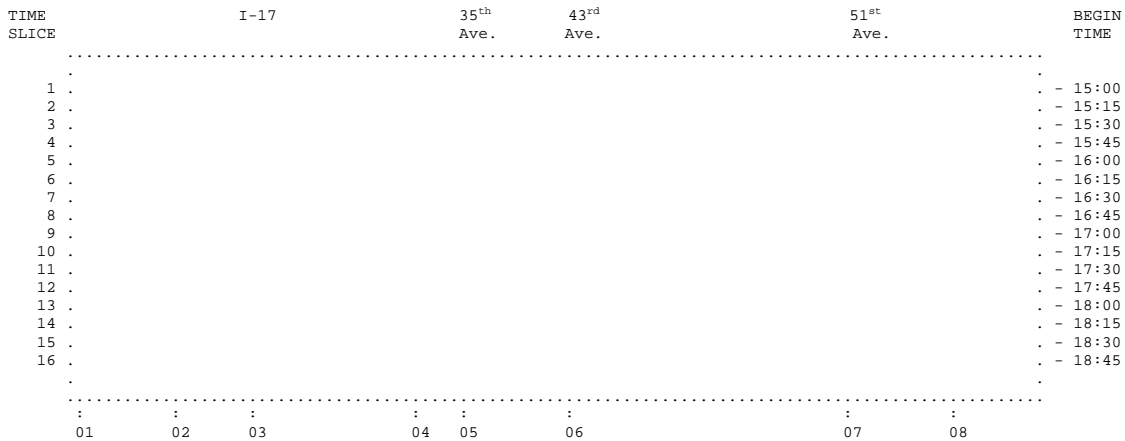
B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

P DENOTES A PRIORITY LANE (HOV).

**Alternative1:** Add a general purpose lane from the I-17 on ramp to the 51<sup>st</sup> Avenue off-ramp making a four-lane cross-section from 35<sup>th</sup> Avenue to 51<sup>st</sup> Avenue.

**Result:** This alternative eliminates congestion within this segment. Overall freeway travel time decreases 10%.

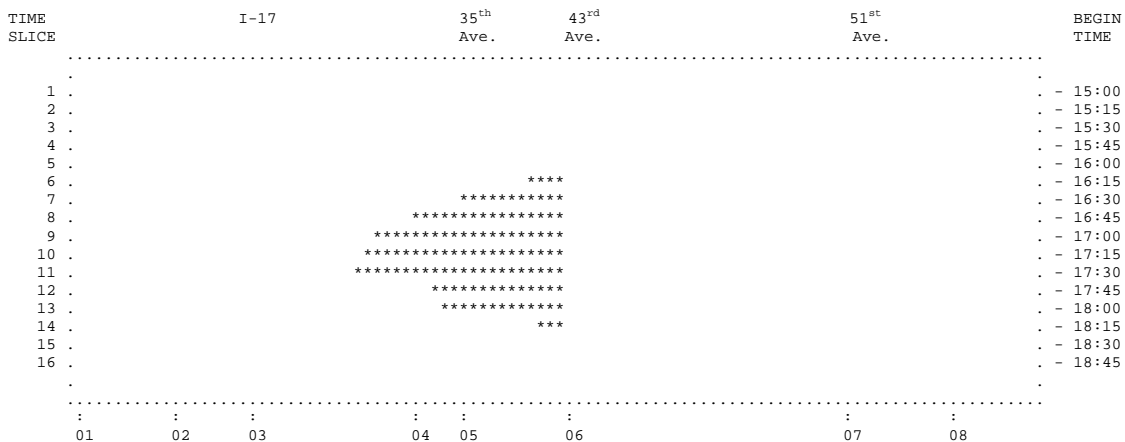
**Queue Diagram of Alternative1 for Segment O:**



**Alternative2:** Add dual ramp metering at 35<sup>th</sup> Avenue allowing 1,600 vehicles per hour.

**Result:** At a 1,600 vehicles per hour metering rate, this alternative does not affect the mainline bottleneck delays.

**Queue Diagram of Alternative2 for segment O:**



## ANALYSIS SUMMARY – SEGMENT O

	<b>Mainline Travel Time (pass-hr)</b>	<b>Ramp Delay (pass-hr)</b>	<b>Total Freeway Travel Time (pass-hr)</b>	<b>Average Speed (mph)</b>
Existing Conditions	2077	3610	5687	50.7
Alternative1	1562	3610	5172	67.4
Alternative2	2077	3610	5687	50.7

### Conclusions/Recommendations:

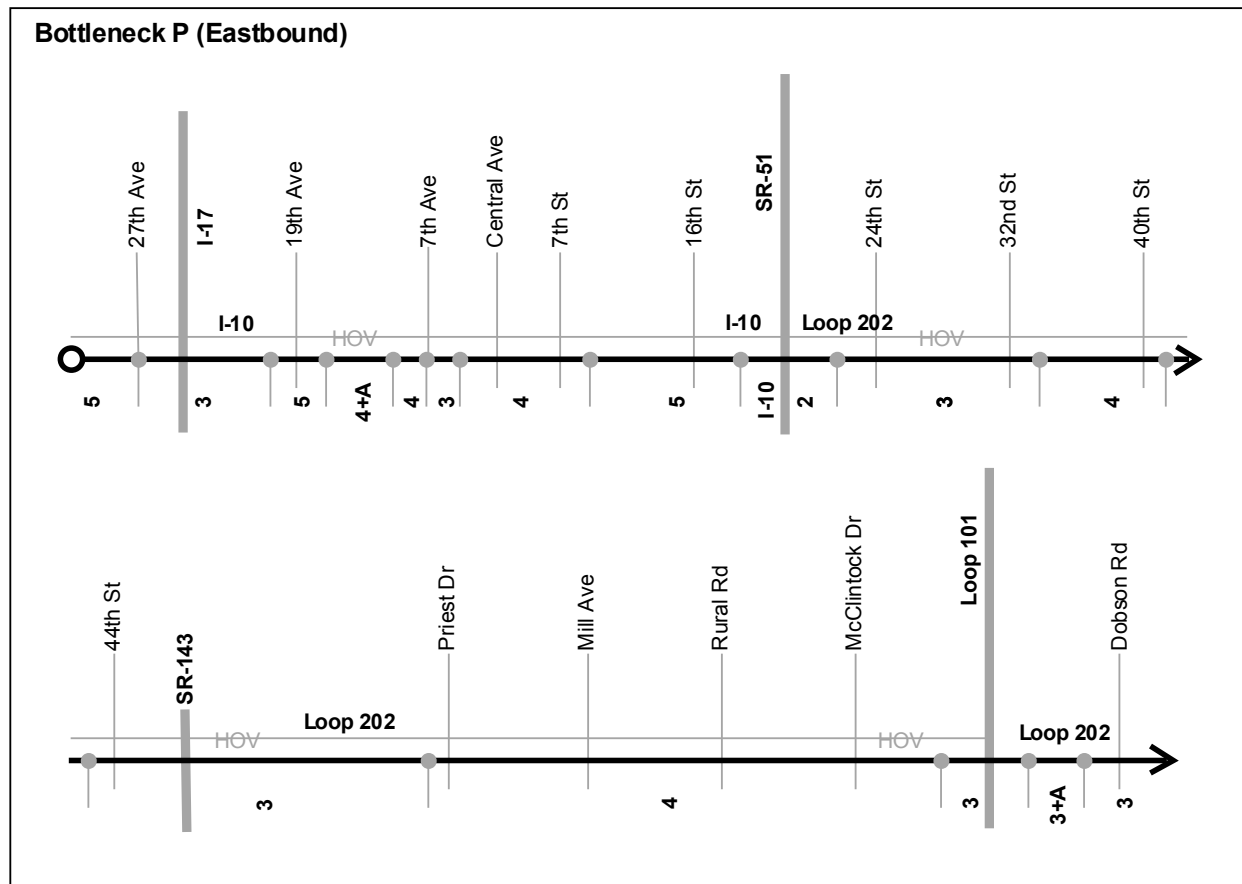
1. On this section of Loop 101, a fourth general purpose lane is needed from 35<sup>th</sup> Avenue to 51<sup>st</sup> Avenue.
2. Implementation of dual lane ramp metering at 35<sup>th</sup> Avenue will have little impact on the existing level of mainline congestion.

**SEGMENT P**  
**LOOP 202 EASTBOUND: 27<sup>TH</sup> AVENUE (ON I-10) TO DOBSON ROAD**  
**EVENING PEAK PERIOD**

**EXISTING CONDITIONS**

*Geometrics:*

The following schematic illustrates the lane configuration along the P bottleneck segment. Lane numbers are shown below the black line. The letter “A” indicates an auxiliary lane, and the presence of an HOV lane is indicated by a light gray line just above the black line.



*Daily Traffic Volume, Both Directions:*

Daily traffic volume along this bottleneck segment reaches a maximum of 259,000 vehicles (vpd) at the intersection of I-10 and 7<sup>th</sup> St. The volume at this location during the PM peak hour is 16,200 for General Purpose lanes and 3,000 for HOV lanes. These combined peak hour volumes represent 7.4% of the total daily volume.

*Eastbound Traffic Volumes:*

The volumes shown in the table below represent eastbound counts along the P bottleneck segment. Where available, peak hour counts are shown separately for General Purpose and HOV lanes.

**TRAFFIC VOLUMES**

<b>Location</b>	<b>PM Peak Hour Total Volume</b>	<b>PM Peak Hour GP Volume</b>	<b>PM Peak Hour HOV Volume</b>	<b>Percent Peak Hour</b>	<b>Percent Peak Hour Trucks</b>
I-10 / 31 <sup>st</sup> Av	7,300	6,700	600	6.5%	3.9%
I-10 / 7 <sup>th</sup> Av	8,300	7,500	800	6.6%	-----
I-10 / 16 <sup>th</sup> St	9,500	8,100	1,400	7.8%	2.3%
Loop 202 / 32 <sup>nd</sup> St	7,600	6,500	1,100	7.3%	0.5%
Loop 202 / Mill Av	9,200	8,100	1,100	8.5%	0.6%
Loop 202 / Dobson Rd	5,600	-----	-----	12.2%	-----

**CRASH DATA**

Crash data for the years 1998, 1999, and 2000 are shown in the following tables.

**CRASH DATA – COLLISION TYPE**

<b>Year</b>	<b>Total Crashes</b>	<b>Crash Rate</b>	<b>Rear End</b>	<b>Sideswipe</b>	<b>Single Vehicle</b>	<b>Other</b>
<b>1998</b>	873	1.57	568	128	137	40
<b>1999</b>	995	1.70	648	161	146	40
<b>2000</b>	1099	1.80	736	200	125	38
<b>Total</b>	2967	1.69	1952	489	408	118

**CRASH DATA – SEVERITY**

<b>Year</b>	<b>Total Crashes</b>	<b>PDO</b>	<b>Injury</b>	<b>Fatal</b>	<b>Truck Involved</b>
<b>1998</b>	873	638	233	2	32
<b>1999</b>	995	699	295	1	49
<b>2000</b>	1099	757	341	1	47
<b>Total</b>	2967	2094	869	4	128

## SKYCOMP FINDINGS

The level of service, as observed by Skycomp, is presented on the following two pages.

**Observations:** During the peak period, eastbound congestion was typically found in the freeway ramp from I-10 to Loop 202; this congestion appeared to be caused or exacerbated by weaving east of the SR-51/Loop 202/ I-10 interchange.

On one day only, a short zone of eastbound congestion was found on Loop 202 between I-10/SR-51 and 24<sup>th</sup> Street; traffic entering at 24<sup>th</sup> Street appeared to cause or exacerbate the congestion.

During most observations, eastbound congestion was found on Loop 202 between SR-143 and Loop 101 (Pima Freeway); vehicles merging into the two right lanes to exit at Loop 101 appeared to cause or exacerbate the congestion. West of McClintock Drive, the congestion extended across all four lanes. During the peak period, average estimated speeds along this segment typically ranged from approximately 20 to 30 mph.

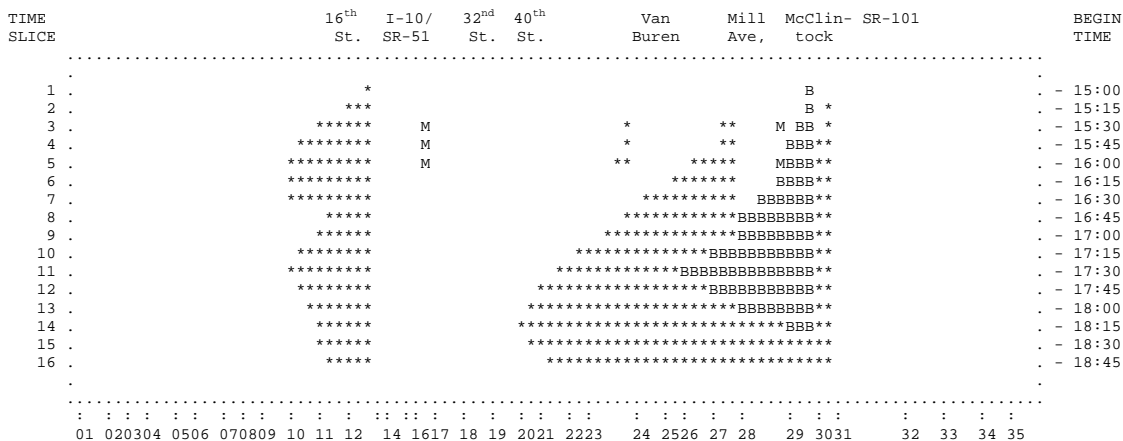
**Density Data:** Level of Service F (density greater than 45 vehicles per lane-mile) westbound between 24<sup>th</sup> Street and 32<sup>nd</sup> Street between 3:30 and 4:00 pm and again between 5:00 and 6:00 pm; Level of Service F eastbound between Van Buren Street and 56<sup>th</sup> Street between 5:00 and 6:30 pm; between 56<sup>th</sup> Street and McClintock Drive between 3:20 and 6:30 pm.

## FREQ ANALYSIS

**Segment P: Loop 202 EB; 27th Avenue to Dobson Rd; 3:00 to 7:00 pm**

**Existing Conditions:** Existing bottlenecks occur at the I-10/SR-51/Loop 202 interchange, Mill Avenue, and the McClintock Road /Loop 101 interchange area.

### Queue Diagram of Existing Conditions for Segment P:



#### Queue Diagram Key:

BLANK DENOTES UNCONGESTED TRAFFIC.

ASTERISK DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION.

M DENOTES QUEUED VEHICLES DUE TO MERGING.

B DENOTES QUEUED VEHICLES DUE TO MAINLINE CONGESTION AND MERGING.

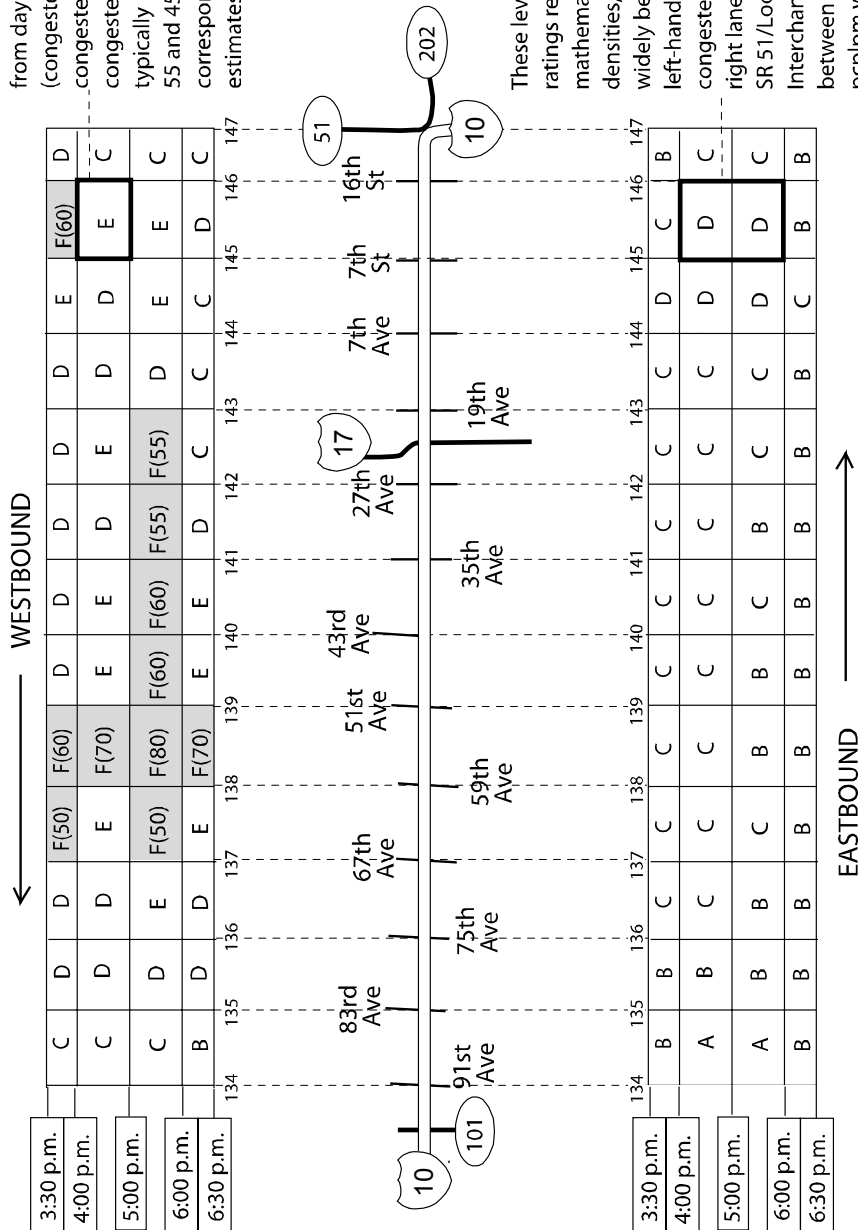
P DENOTES A PRIORITY LANE (HOV).



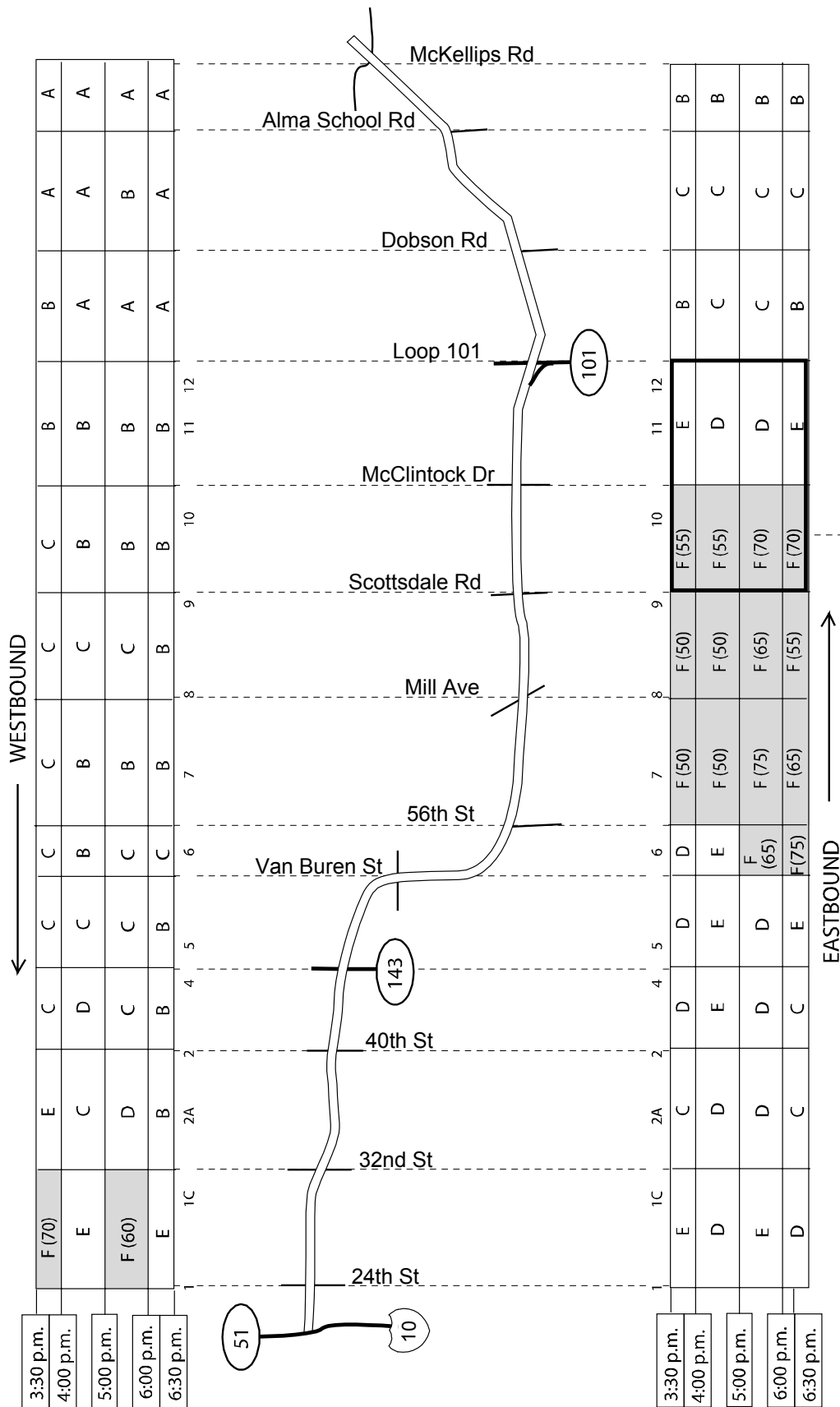
**I-10**  
**(Between 91st Ave & Loop 202 / SR 51)**  
**Evening - Fall 2001**

These level-of-service ratings represent the mathematical average of densities, which varied from day-to-day (congested/not congested); when congested, densities typically ranged between 55 and 45 pcplpm with corresponding speed estimates of 40 to 50 mph.

These level-of-service ratings represent the mathematical average of densities, which varied widely between right- and left-hand lanes. When congested densities in the right lane approaching the SR 51/Loop 202/I-10 Interchange ranged between 55 and 45 pcplpm with corresponding speed estimates of 40 to 50 mph.



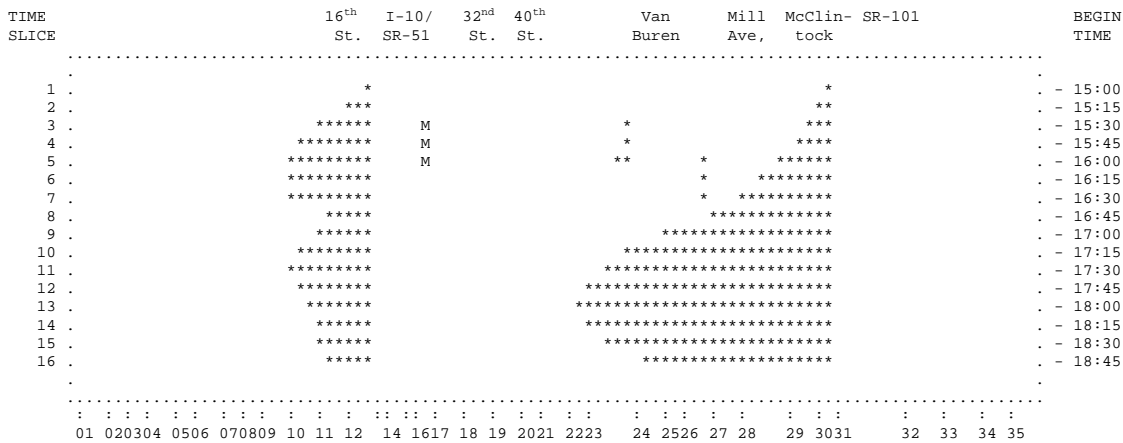
## Loop 202 Evening - Fall 2001



**Alternative1:** Add auxiliary lanes at Mill Avenue and McClintock Road.

**Result:** This alternative reduces congestion at the Mill Avenue bottleneck, however, does not affect the downstream bottlenecks at McClintock Road and the Loop 202/Loop 101 interchange. Overall freeway travel time decreases 3%. Widening of Loop 202 in the vicinity of Loop 101 will be costly since the entire freeway is on structure.

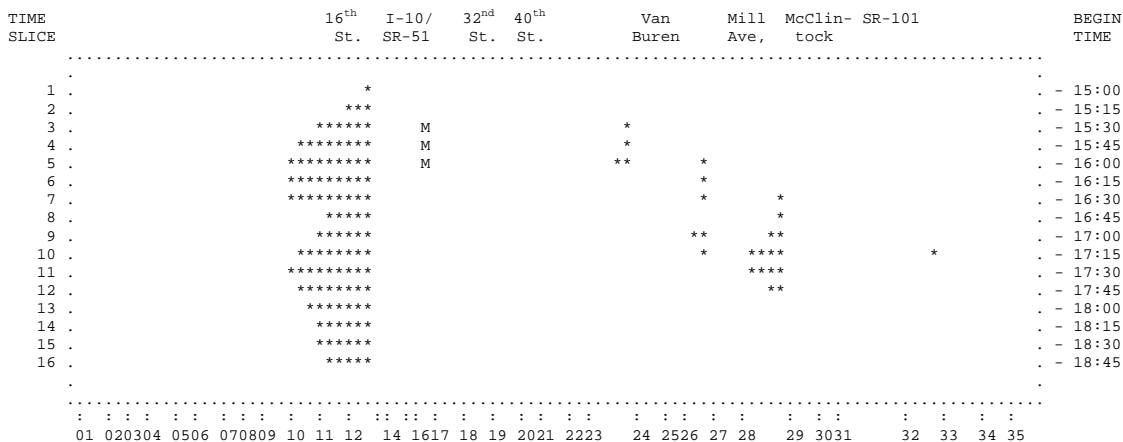
**Queue Diagram of Alternative1 for Segment P:**



**Alternative2:** At the Loop 101/Loop 202 interchange, make the Loop 101 off-ramp a two-lane mandatory off-ramp in addition to the auxiliary lanes added at Mill Avenue.

**Result:** This alternative significantly reduced congestion at Mill Avenue and the McClintock Drive/Loop 101 interchange. Overall, freeway travel time decreases 8%.

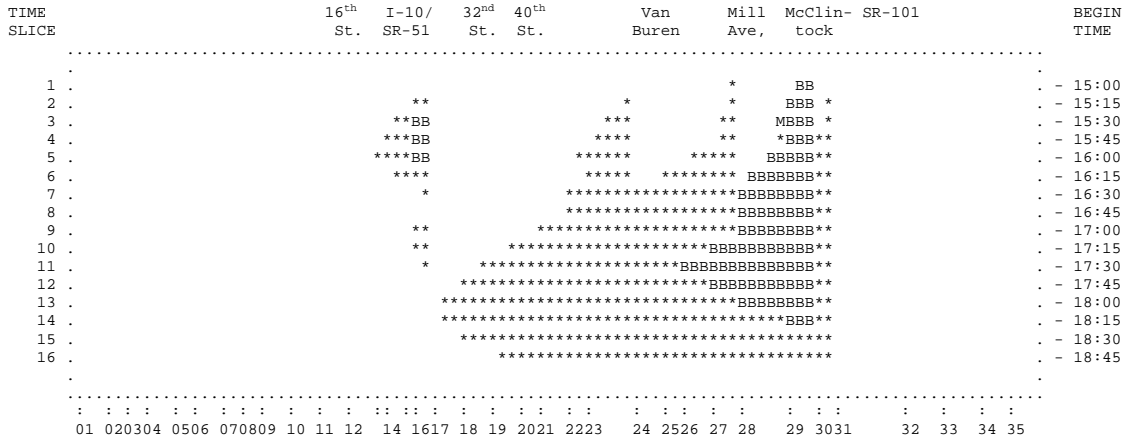
**Queue Diagram of Alternative2 for Segment P:**



**Alternative3:** Add a third lane to the I-10 to Loop 202 connector ramp.

**Result:** This alternative significantly reduced the congestion at the Loop 202 interchange, however, increased demand downstream produces added congestion at 24<sup>th</sup> Street, Mill Avenue, and McClintock Road/Loop 101. Overall freeway travel time decreases 2%.

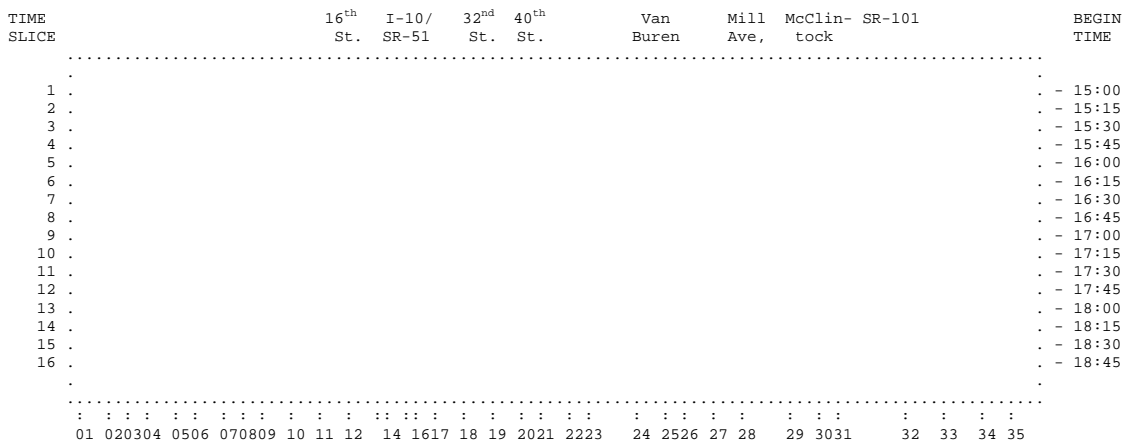
### Queue Diagram of Alternative3 for Segment P:



**Alternative4:** At the Loop 101/Loop 202 interchange, make the Loop 101 off-ramp a two-lane mandatory off-ramp and include the auxiliary lanes at McClintock Road and at Mill Avenue as in Alternative 2. This also includes the I-10 interchange improvements in Alternative 3.

**Result:** This Alternative removes the delays, but would be a very costly improvement.

### Queue Diagram of Alternative4 for segment P:



### Analysis Summary – Segment P

	<b>Mainline Travel Time (pass-hr)</b>	<b>Ramp Delay (pass-hr)</b>	<b>Total Freeway Travel Time (pass-hr)</b>	<b>Average Speed (mph)</b>
Existing Conditions	22215	27378	49593	21.4
Alternative1	21468	27080	48549	22.3
Alternative2	14121	31372	45493	34.9
Alternative3	21153	27350	48503	22.6
Alternative4	10881	31959	42841	46.4

#### Conclusions/Recommendations:

1. Additional capacity is needed on the I-10 to Loop 202 connector ramp, the Loop 202 to Loop 101 connector ramp, and on Loop 202 between Mill Avenue and McClintock Road. Adding additional lanes to the connector ramps and auxiliary lanes between Mill Avenue and McClintock Road should be considered, although all of these segments are currently on structure.